EVALUATING THE RELATIONSHIP BETWEEN CHC FACTORS AND INDEPENDENT LIVING SKILLS IN COLLEGE STUDENTS

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CHAPTER I

INTRODUCTION

Overview

Despite the prevalence of the Cattell-Horn-Carroll (CHC) theory (McGrew, 1997) being utilized to conceptualize intelligence and inform assessment of cognitive abilities (Sotelo-Dynega & Dixon, 2014), there has been little investigation between CHC factors and measures of functional skills, such as independent living skills. CHC theory is a widely accepted and well-validated three-stratum theory of intelligence (McGrew, 2014). Many intelligence tests utilize CHC theory as their primary theoretical rationale; the *Woodcock-Johnson - 4th Edition Test of Cognitive Abilities* (WJ-IV-COG; Schrank, McGrew, & Mather, 2014) has been considered for some time a test which encompasses CHC theory well (Flanagan, Ortiz, & Alfonso, 2013). The WJ-IV-COG measures seven of the CHC broad ability factors: comprehension-knowledge (*Gc*), fluid reasoning (*Gf*), short-term working memory (*Gwm*), processing speed (*Gc*), auditory processing (*Ga*), long-term retrieval (*Glr*), and visual processing (*Gv*; McGrew, LaForte, & Schrank, 2014).

As a measure of independent living skills, the American Psychological Association (APA) and American Bar Association (ABA) recommend the use of the *Independent Living Scales* (ILS: Loeb, 1996), especially in the context of capacity evaluations (ABA & APA, 2008). This test of independent living measures multiple subdomains of independent living skills including memory and orientation, ability to manage money, ability to manage one's home, transportation knowledge, health and safety knowledge, and social adjustment (Loeb, 1996). There is a lack of research examining the relationship between various components of independent living skills and CHC factors. However, both researchers and clinicians use

measures of intelligence to infer functional deficits and suggest interventions and accommodations, despite the unclear relationship between intelligence and various independent living skills. This study investigated the relationship between independent living skills and intelligence through a CHC theoretical orientation.

Intelligence

In Western psychology, the development of intelligence testing and intelligence theory can be traced back to Binet's initial intelligence testing of French children (Binet, 1903), and Spearman's conceptualization of *g* (Spearman, 1904). Binet, along with Simon, developed the first IQ test, the *Binet-Simon Scale* (Binet & Simon, 1916). This initial intelligence test was later revised by Terman to create the *Stanford-Binet Intelligence Scale* (Terman, 1916), which has since been revised multiple times and remains in use today. These aforementioned initial intelligence tests were designed for use with children. Adult intelligence testing can be traced back to the use of *Army Alpha* and *Army Beta* tests (Yoakum & Yerkes, 1920). Together, these tests of intelligence influenced later psychologists to develop and distribute their own measures of intelligence, such as the Wechsler Intelligence Scales and the Woodcock-Johnson batteries.

The theoretical conceptualization of intelligence initially developed independently from IQ tests (Bartholomew, 2004). As intelligence theory evolved from a unitary *g*, to a multifactor *Gc-Gf* model (Cattell & Horn, 1971), to a hierarchical model (Carroll, 1993), intelligence theory became more integrated with the development of intelligence tests, as Carroll's (1993) model was created with the aid of exploratory factor analysis of intelligence tests (Schrank et al., 2010). Cattell and Horn's model and Carroll's model were later integrated into what is now called Cattell-Horn-Carroll (CHC) theory (McGrew, 2014). CHC theory is a model of intelligence which consists of three-stratum, or levels, of cognitive abilities including *g*, broad factors or

abilities, and narrow factors or abilities (McGrew, 2014). The current model of CHC theory includes 12 broad factors, an additional 7 tentative broad factors still being researched, and over 80 narrow abilities (McGrew & Schneider, 2018). CHC theory is used as a primary theoretical rationale for many current intelligence tests, and is used as a secondary rationale, or in conjunction with another theory, on other current intelligence tests (Flanagan, Ortiz, & Alfonso, 2013). A survey of school psychologists indicated a majority (66.7%) adhere to a CHC theoretical orientation as a basis of their evaluations (Sotelo-Dynega & Dixon, 2014).

Research has shown intelligence is influenced by both genetics (Arslan & Penke, 2015) and environment (Mandelman & Gringorneko, 2011), as well as by an interaction between the two (Sauce & Matzel, 2018). Factors related to intelligence test performance include socioeconomic status (SES), acculturation, educational attainment, parental level of education, and occupation (Kendler et al., 2015; Rindermann & Thompson, 2016; Sauce & Matzel, 2018; Tucker-Drob, Rhemtulla, Harden Turkheimer, & Fask, 2011). Furthermore, gene-environment interactions have been linked to the Flynn effect, as the increases in IQ over time have been associated with improvements in education and nutrition which can contribute to the multiplier effects seen in gene-environment interactions (Pietschnig & Voracek, 2015).

Independent Living Skills

Some type of assessment of a patient's ability to independently complete age-appropriate activities of daily living or adaptive behavior is commonly included in psychological and neuropsychological evaluations to aid in the determination of functional deficits, in differential diagnosis, to inform interventions, and to inform capacity and competency determinations. Both 'adaptive behavior' and 'activities of daily living' are umbrella terms referring to a wide range of skills needed in everyday life and they consist of requisite skills for independent living. Adaptive

behavior appears to be the term generally utilized primarily in the pediatric literature or when in reference to neurodevelopmental disorders, whereas activities of daily living is generally utilized primarily in the adult and geriatric literature or when in reference to neurocognitive disorders. Adaptive behavior is most often conceptualized to include conceptual skills, practical skills, and social skills; this is a model that has been promoted by the American Association on Intellectual and Developmental Disabilities (AAIDD; Wei, Oakland, & Algina, 2008) and reflected in the diagnostic considerations for Intellectual Disability as written in the *Diagnostic and Statistical Manual of Mental Disorders – 5th Edition* (DSM-5; APA, 2013). Activities of daily living is typically dichotomized into basic activities of daily living (BADLs; e.g. feeding, toileting, bathing, grooming, dressing, etc.) and instrumental activities of daily living (IADLs; e.g. preparing food, managing money, driving or using transportation, managing medication, housekeeping, etc.; Jefferson, Paul, Ozonoff, & Cohen, 2006). As both terms encompass a range of competencies, there is often variation within the literature for which skills or abilities are being assessed under these umbrella terms thus complicating the generalizability of the results and the clinical implications.

The method for evaluating activities of daily living or adaptive behavior varies within the literature, and which method provides the best representation of the person's everyday functioning is still being debated. Self- and informant-reports are commonly used methods; however, these reports have been shown to be subject to bias (Dunning, Heath, & Suls, 2004; Loewenstein et al., 2001; Tucker-Drob, 2011; Wadley, Harrell, & Marson, 2003; Wild & Cortell, 2003). Generally, these studies demonstrated a bias, or lack of insight, in self-reports. Self-reports often demonstrate an overestimation of skills, while informant-reports were found to both over- and underestimate skills. The accuracy of informant-reports is dependent on a number of

variables, such as the number of hours spent with the identified patient, as well as the informant's own cognitive and executive functioning abilities (Dassel & Schmitt, 2008; Sikkes et al., 2008). Another method for assessing activities of daily living is through the use of confrontational performance-based tasks. Research regarding performance-based measures of activities of daily living suggests these behavioral simulation methods are more sensitive to functional deficits than paper-and-pencil tasks (Burgess et al., 2006; Fortin, Godbout, & Braun, 2003; Marcotte & Grant, 2010). However, a noted limitation of this methodology is potentially limited ecological validity as the tasks are performed under contrived clinical or laboratory conditions. As such, task completion may require more abstract thinking or imagination due to limited context clues in a laboratory or clinical setting compared to a naturalistic setting (Robertson & Schmitter-Edgecomber, 2017). Performance-based measures are likely to be reflective of an individual's ability to independently do a task, whereas an informant-report may be more reflective of the individual's perceived performance in everyday settings, which may account for some of the discrepancy within the literature in terms of variance explained by performance-based measures compared to informant questionnaires.

Rationale of the Study

Measurement of intelligence and adaptive behavior are used concomitantly for diagnostic clarity and intervention design in a variety of conditions. Adaptive functioning or ADLs are frequently measured in conjunction with tests of intelligence to determine the functional impact of intellectual performance. Public Law 94-112 (1975) mandates collecting adaptive functioning data for Cognitive Disability special education evaluations; similarly, the DSM-5 (APA, 2013) requires the use of adaptive functioning information to determine diagnostic appropriateness and severity for Intellectual Disability. Furthermore, a wide range of psychiatric and neurological

conditions have been associated with deficits in adaptive behavior and/or activities of daily living. These conditions include, but are not limited to, Autism Spectrum disorder (Adreon, & Durocher, 2007; Farley, et al., 2009; Matson, Dempsey, & Fodstad, 2009), Intellectual Disability (Ditterline, Banner, Oakland, & Becton, 2008; Matson, Dempsey, & Fodstad, 2009; Tabert et al., 2002), Down syndrome (Ditterline, et al., 2008), Specific Learning disorders (Ditterline, et al., 2008), Fragile X syndrome (Fisch, Simensen & Schroer, 2002), Williams syndrome (Mervis & Klein-Tasman, 2000), Traumatic Brain Injury (Lindén, Boschain, Eker, Schalén, & Nordström, 2005), dementia and neurocognitive disorders (Cooke, Fischer, Mayberry, & Oakley, 2000), Multiple Sclerosis (Johansson, et al., 2007), Huntington's disease (Hamilton, et al., 2003), Parkinson's disease (Weintraub, et al., 2004), brain tumors (Huang et al., 2001), Schizophrenia (Narvaez, et al., 2008; Patterson, et al., 2001), visual and hearing impairments (Beach, Robinet, & Hakim-Larson, 1995; Crews & Campbell, 2004), depressive disorders (Adams, Sanders, & Auth, 2004; Rogers & Holm, 2000), Post-Traumatic Stress Disorder (Khalili & Mahmoudi, 2017; Jackson, et al, 2014), externalizing behavior disorders (Clark, Prior, & Kinsella, 2002), as well as other neurodevelopmental disorders (Ditterline, et al., 2008). According to the DSM-5, any psychiatric disorder must have implications for the patient's daily functioning in social, occupational/educational, or other areas, in order to constitute being a 'disorder' (APA, 2013). In clinical practice, a CHC framework may be utilized to conceptualize a patient's cognitive abilities as a part of the diagnostic decision making and formulation of interventions. Understanding a patient's functional skills is another important component of this process; however, there is little to no research relating functional skills to a CHC framework. This study aimed to understand the strength of the relationship between seven broad CHC factors (*Gc, Gf, Gwm, Gs, Ga, Glr, Gv*) and three areas of independent living skills (Managing Money,

Managing Home and Transportation, Health & Safety). By better understanding the strength of this relationship, and which factors contribute most to the relationship, clinicians may be better able to determine functional status, design and implement appropriate interventions, and inform prognoses.

Despite the frequent and concurrent use of measures of independent living skills and intelligence, the relationship between the two constructs remains ambiguous. Given that neuropsychologists and psychologists frequently rely on cognitive data to predict everyday functioning, and the literature currently demonstrates a large range of variability regarding the predictive value of various cognitive abilities and every day functioning, understanding the relationship between cognitive variables and activities of daily living is important for clinical practice. In both research and clinical practice, there is a discrepancy between conceptualizations of functional skills, as adaptive behavior, activities of daily living and independent living skills all are terms which include a range of skills.

Moreover, the methodology used to assess these skills varies across the literature. Self-reports have been shown to be overestimates compared to measured skills in a variety of domains, and these self-assessments can be subject to many possible sources of bias (e.g. above-average effects, the planning fallacy, impression management, overconfidence, poor insight, etc.; Dunnning, Health, & Suls, 2004: Tucker-Drob, 2011). Likewise, informant-reports have also been shown to be subject to possible sources of bias, such as information deficits, limited time spent with the patient, lack of opportunity to observe the skill(s), incorrect attributions (i.e. attributing a patient's inability to complete a task as an unwillingness to do so or vice versa), or as a result of the informant's cognitive or executive functioning abilities (Dassel & Schmitt, 2008; Loewenstein et al., 2001; Sikkes et al., 2008; Tucker-Drob, 2011). As such, the present

study administered a performance-based measure of functional skills, the *Independent Living Scale* (ILS; Loeb, 1996), in attempts to reduce the impact of self or reporter bias. By utilizing the ILS, the current study measured three areas of independent living skills (managing money, managing home and transportation, and health and safety) via confrontational tasks which follow a standardized scoring procedure to minimize potential self or reporter bias on quality of task completion.

Significance of the Study

The American Psychological Association (APA) and the American Bar Association (ABA) recommended the use of the ILS in judicial competency evaluations regarding independent living skills (ABA & APA, 2008). Confrontational measures of ADLs, specifically the ILS, are preferred in judiciary decisions (ABA & APA, 2008: Quickel & Demakis, 2013), the ILS is recommended by the APA and ABA, and would limit the amount of potential reporter bias. As such, the ILS was selected as a measure of independent living skills for the study. The ILS is not well researched or utilized in a college population (Johnson, 2015); however, competency decisions can be necessary throughout all of adulthood (Marcotte & Grant, 2010). Additionally, vocational rehabilitation services for individuals with disabilities has been required by law since the passing of the Rehabilitation Act of 1973. Vocational rehabilitation services include evaluations of an individual's strengths and weaknesses, as well as their current level of independent living skills and ability to acquire daily living skills (Family & Social Services Administration, 2018). A confirmatory factor analysis of the ILS Managing Money and Health & Safety subtests was conducted on a non-referred college sample, and supported the use of these subtests with this population (Johnson, 2015). Further investigations into the utility of the ILS in a college sample are needed to more fully understand the validity of this measure within this age

demographic. The current study aimed to compare the performance of a non-clinical, independently living, college sample against the established cut-points on the ILS from the normative sample of independently living older adults (Loeb, 1996). Additionally, the performance of the non-clinical, independently living, college sample will be compared to the more recently established cut-points by Quickel & Demakis (2013) which were created in relation to their sensitivity and specificity in predicting judiciary competency decisions for independent living.

Additionally, CHC theory presents an ideal framework for investigating the relationship between intelligence and independent living skills, as the latter consists of a wide variety of skills or abilities which have been shown to be disparately related to cognitive abilities (Chevignard et al., 2010; Fortin, 2003: Griffith et al., 2010; McAlister et al., 2016; Yoon et al., 2013). The use of a hierarchal model of intelligence allows for the relationship between intelligence and independent living skills to be evaluated at multiple levels, in order to gain a better understanding of the nature of their relationship. CHC theory, which is the basis of the WJ-IV-COG includes an overall composite, broad ability factors, and narrow ability factors. The core of the WJ-IV-COG measures seven broad CHC factors (*Gc, Gf, Gwm, Gs, Ga, Glr*, Gv; Schrank, McGrew, & Mather, 2014), and results in a measure of global intelligence, the General Intellectual Ability (GIA), which is thought to be analogous to *g*. These broad ability factors provide a basis for understanding a person's cognitive strengths and weakness; however, this strengths and weaknesses profile as measured by the WJ-IV-COG may not provide adequate information regarding the individual's functional behavior on its own, specifically their independent living skills, as there is currently little research investigating how independent living skills are related to CHC factors. Therefore, understanding how the seven broad CHC factors on

the WJ-IV-COG (*Gc, Gf, Gwm, Gs, Ga, Glr, Gv*) relate to three areas of independent living skills on the ILS (Managing Money, Managing Home and Transportation, and Health and Safety) could provide important information for conceptualizing a patient's strengths and weakness, as well as which areas of intervention or accommodation may provide the most functional benefit to the client. Furthermore, understanding how well GIA might predict independent living skills will aid in clinicians' abilities to extrapolate functional skills from measures of *g.*

The WJ-IV-COG is well validated in a typical college population; therefore, it is a good metric to use for comparison with the ILS, which has not been well studied in this population. It is important to understand the relationship between the constructs measured on the ILS (managing money, managing home and transportation, and health and safety) and the broad factors in CHC theory on the WJ-IV-COG (*Gc, Gf, Gwm, Gs, Ga, Glr,* Gv) to further understand the nature and extent of the relationship between the various aspects of intelligence and the various aspects of independent living skills to better inform diagnostic decision making, intervention development and implementation, and prognostic determinations.

Research Questions

1. Is there a significant canonical correlation between the 7 broad CHC factors (Gc, Gf, Gwm, Gs, Ga, Glr, Gv) and tests of independent living skills (Managing Money, Managing Home and Transportation, and Health & Safety)?
    a. Hypothesis: Crystalized Intelligence, as measured by Oral Vocabulary, will most strongly relate to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Many of the ILS items rely on knowledge of concepts (e.g. financial terms, household chores, transportation and communication methods, medical care, self-care, etc.) and ability to communicate

that knowledge successfully; therefore, it is likely these subtests (Managing Money, Managing Home and Transportation, and Health & Safety) will more strongly relate to crystalized intelligence than other CHC broad abilities.

b. Hypothesis: Fluid Reasoning, as measured by Number Series, will moderately relate to the ILS subtests (Managing Money Managing Home and Transportation, and Health & Safety). A smaller portion of ILS items rely on problem solving ability in real-life scenarios (e.g. paying bills, handling emergencies in the home, and handling medical emergencies); therefore, it is likely these subtests (Managing Money, Managing Home and Transportation, and Health & Safety) will moderately relate to fluid reasoning.

c. Hypothesis: Short-Term Working Memory, as measured by Verbal Attention, Cognitive Processing Speed, as measured by Letter-Pattern Matching, Auditory Processing, as measured by Phonological Processing, Long-Term Retrieval, as measured by Story Recall, and Visual Processing, as measured by Visualization, will mildly relate to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Given administration guidelines on the ILS, it is likely short-term working memory, long-term retrieval, and cognitive processing speed will be only minimally related to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Additionally, because items are mostly based on verbal problem solving, it is likely visual processing will be minimally related to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety).

   d. Hypothesis: Managing Home and Transportation will contribute most to the relationship with the 7 broad CHC factors (*Gc, Gf, Gwm, Gs, Ga, Glr, Gv*). Managing Home and Transportation on the ILS correlated with Full Scale IQ (FSIQ), another global measure of intellectual functioning, on the *Wechsler Adult Intelligence Scale-Revised* (WAIS-R; Wechsler, 1981) 0.78; while Managing Money correlated with FSIQ 0.76 and Health and Safety correlated with FSIQ 0.70 (Loeb, 1996).

2. Does the GIA on the WJ-IV-COG significantly predict performance on the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety)?
   a. Hypothesis: The GIA on the WJ-IV-COG will significantly and largely equally predict performance on Managing Money, Managing Home and Transportation, and Health & Safety. In the ILS standardization sample, correlations between Managing Money, Managing Home and Transportation, and Health & Safety, and the Full-Scale IQ, a measure considered analogous to *g*, on the WAIS-R ranged from 0.70 to 0.78 (Loeb, 1996). These similar correlations suggest it is likely GAI on the WJ-IV-COG, another measure considered analogous to *g*, will significantly predict ILS performance although will not significantly better predict one ILS subtest over another.
3. Will a non-referred college sample exceed the competency cut-off scores created by Loeb (1996)?
   a. Hypothesis: The non-referred college participants will likely exceed the competency cut-off scores for Managing Money, Managing Home and Transportation, and Health & Safety although likely not as much as the

standardization sample. If the ILS is functioning similarly in a college sample as in a sample of older adults, which were used to create the competency cut-off scores, the college participants should score above the cut-off scores. Some of the items, however, may not relate as well to a younger sample more used to performing activities of daily living using the internet than when the test was created.

4. Will a non-referred college sample exceed the competency cut-off scores created by Quickel & Demakis (2013)?
    a. Hypothesis: The college participants will likely exceed the competency cut-off scores for Managing Money and Managing Home and Transportation. If the college sample exceeds the competency cut-off scores created by Loeb (1996) as discussed above, they will also exceed the less stringent competency cut-off scores created by Quickel & Demais (2013). If the ILS is functioning similarly in a college sample as in a sample of adults with Schizophrenia, which were used to create the competency cut-off scores, the college participants should score above the cut-off scores as the participants are not a clinical inpatient sample.

CHAPTER II

REVIEW OF THE LITERATURE

This review of the literature is comprised of four sections relevant to the present investigation. The first section encompasses a review of the construct of intelligence and intelligence testing. The second section consists of an overview of research regarding independent living skills, utilized measurements strategies, and ongoing debate in the literature regarding those measurement strategies. Thirdly, a review of research regarding the relationship between independent living skills and intelligence and other cognitive constructs is presented with an emphasis on functional neuroanatomy. The fourth section concludes the literature review with an overall summary of the findings and its implications for the present investigation.

Intelligence

For centuries, scientists and psychologists have been debating definitions of, and attempting to measure, the construct of intelligence. The construct of intelligence in Western psychology primarily developed along two paths: Binet, Terman and Wechsler and the development of Intelligence Quotient (IQ) measures, and Charles Spearman and subsequent factor analysis of *g* (Bartholomew, 2004). Although IQ and *g* are sometimes used interchangeably in the literature, they represent distinct concepts with convergent histories.

Some form of methodology has existed to analyze peoples' abilities for hundreds of years. In fact, an early form of an ability test, measuring bureaucratic abilities, can be traced back over 2,000 years in China (French & Hale, 1990). Early forms of intelligence tests were designed primarily to organize and classify people into groups, and have been present in a variety of cultures. In Western psychology, the development of intelligence tests can be credited to Alfred Binet's (1903) early work in identifying children who required an alternative education in France (Bartholomew, 2004). Binet, along with Simon, developed the first IQ test, the *Binet-*

Simon Scale (Binet & Simon, 1916) to achieve this goal. Terman revised the *Binet-Simon Scale* to create the *Stanford-Binet Intelligence Scale* (Terman, 1916), which has since been revised and remains in use today. Terman, in addition to Yerkes and other psychologists, helped to develop and implement the *Army Alpha* and *Army Beta* tests, which were the first group administered intelligence tests (Yoakum & Yerkes, 1920). Similar to previous intelligence measures, the goal of the Army Alpha and Army Beta was to categorize soldiers into groups which determined level of training and future rank (Yoakum & Yerkes, 1920). The *Stanford-Binet Scale* was influential in Wechsler's development of his intelligence test, originally the *Wechsler-Bellevue Intelligence Scale* (Wechsler, 1939). Wechsler went on to develop several intelligence tests for preschool children through adults, which have been revised and are still popular today (Rabin, Paolillo, & Barr, 2016).

Binet was primarily interested in measuring intelligence in children to inform educational decisions, which lead to the conceptualization of mental age (Goodwin, 2015). Mental age was calculated by comparing the child's performance on an intelligence test with the abilities expected of children at that age (Thurston, 1926). For example, if an 8-year-old child performed all the tasks expected of an 8-year-old child but nothing beyond that point, the child's mental age would be considered to be 8 years old. The comparison between mental age and chronological age allowed for a systematic judgment of whether the child was advanced, average, or delayed, and to what degree (Bartholomew, 2004). The quotient of the mental age divided by the chronological age was known as the Intelligence Quotient (IQ; Bartholomew, 2004). This original conceptualization of IQ was designed for use with children. In adulthood, mental ability was not thought to continue to increase steadily throughout the lifespan, and mental age would eventually cease to increase while chronological age would continue to increase, thus

systematically lowering the IQ score derived in the method. The lack of generalizability of this definition of IQ to adults, as well as to children at the extremes of the ability range, was addressed by the new definition of IQ proposed by Wechsler around 1939. He proposed a new system for calculating IQ by comparing a person's scores to average scores of people the same age (Bartholomew, 2004). Wechsler scaled his tests to have a mean of 100 and a standard score of 15, which has continued to be a commonly used scale for modern IQ tests (Sattler, 2008).

Conversely, the theoretical study of intelligence as an overall ability factor can be originally traced back to Galton's *Hereditary Genius* (1869), in which he attempted to study how human ability was an inheritable construct. The concept of an overall ability level was first introduced as a quantifiable construct, also known as *g*, by Spearman in 1904 (Spearman, 1904). Jensen continued to advocate for mainstream acceptance of *g* in scientific applications, or as he describe it, 'the *g* factor' (Jensen, 1987; Jenson, 1998; Jensen & Weng, 1994). Approximately around time of the first development of IQ tests by Binet and Terman, Spearman published *'General Intelligence' Objectively Determined and Measured* which outlined the first factor analysis (Spearman 1904). From this analysis, he proposed a two-factor theory, including the common factor (*g*) and the specific factor (Bartholomew, 2004). Thurston (1938) extended Spearman's two-factor theory into a multiple factor model, with multiple abilities represented in addition to *g* (Gardner, Kornhaber, & Wake, 1996). The debate between these two models of intelligence came to an apparent resolution with the development of hierarchical factor analysis which allowed the seemingly disparate models to co-exist by positing that multiple factors could contribute to test performance while maintaining an underlying common factor, *g* (Bartholomew, 2004).

Cattell (1963) and Horn (1965) further developed the concept of multifactor theories of intelligence with their model of intelligence, which did not include a measure of *g*, but instead focused on broad factors of intelligence such as fluid ability (*Gf*), crystallized ability (*Gc*), general visualization (*Gv*), general fluency (*Gr*), and general speediness (*Gs*; Garnder et al, 1996). Cattell and Horn's theory (1971) was expanded to include as many as 10 broad factors, which became known as *Gf-Gc* theory (Schrank, Miller, Wendling, & Woodcock, 2010). Carroll (1993) was influenced by the concepts outlined in *Gf-Gc* theory, and created his own three stratum theory through the use of exploratory factor analysis of intelligence tests (Schrank et al., 2010). Carrol's three stratum theory identified a general intelligence factor (*g*), eight broad abilities, and 70 narrow abilities (Schrank et al., 2010).

In the late 1990's, McGrew proposed an "integrated" *Gf-Gc* theory in attempts to resolve the differences between Cattell and Horn's model and Carroll's model (McGrew, 1997). This became known as the Cattell-Horn-Carroll (CHC) three-stratum theory (McGrew, 2014). The CHC model of intelligence consists of three stratum, or levels, of cognitive abilities including *g*, broad abilities, and narrow abilities, a similar structure as Carrol's three stratum theory (Flanagan, Ortiz, & Alfonso, 2013). The broad abilities reflect some constructs originating in Cattell and Horn's *Gf-Gc* theory with additional abilities also represented, including fluid reasoning (*Gf*), crystallized intelligence (*Gc*), quantitative knowledge (*Gq*), visual processing (*Gv*), auditory processing (*Ga*), short-term memory (*Gsm*), long-term storage and retrieval (*Glr*), processing speed (*Gs*), reaction and decision speed (*Gt*), and reading and writing (*Grw*). Each broad ability has narrow abilities subsuming it, which are considered to be more specific abilities that factor into the more general broad ability creating a hierarchical model of intelligence. The addition of *g* to Cattell and Horn's *Gf-Gc* theory reflected factor analysis data, as an underlying *g*

has been identified in most intelligence test measures (Johnson, Bouchard, Krueger, McGue, & Gottseman, 2004), and inter-correlation between subtests of intelligence tests suggests an underlying *g* factor (Deary, 2001; Floyd, McGrew, & Evans, 2008). The *Woodcock-Johnson III Normative Update Tests of Cognitive Abilities* (WJ-III-NU-COG; Woodcock, McGrew, & Mather, 2001, 2007) was the first cognitive test to be based on CHC theory (Flanagan, Ortiz, & Alfonso, 2013). Over the years, CHC theory has been refined and expanded. The most current model consists of 12 board factors, with an additional 7 tentative broad abilities, and over 80 narrow abilities (McGrew & Schneider, 2018). Despite the large number of factors in CHC theory, most commonly used cognitive, achievement, or neuropsychological tests that consider these factors measure about 9 broad abilities and around 35-40 narrow abilities (Flanagan, Ortiz, & Alfonso, 2013)

This merging of *g* with specific tests of intelligence, which are generally considered to measure IQ, represents a point of debate among psychologists (Eysenck, 2012; Fletcher & Hattie, 2011). IQ is measurable by intelligence tests; however, intelligence as a theoretical and overarching concept (*g*) may or may not be captured by an intelligence test. Intelligence is commonly quantified as IQ, rather than the latent variable (*g*). IQ is theorized to be a measurement analogous to *g*; however, the degree to which IQ reflects *g* remains controversial. Those who criticize IQ have arguments based in the seemingly arbitrary nature of the selection of test items (Eysenck, 2012). As test developers are unable to directly measure *g*, they must instead pick test items that seem to be indicative of intelligence (Fletcher & Hattie, 2011). Additionally, the cultural bias in test items is another frequent criticism of IQ (Jencks & Phillips, 2011; Reynolds, Lvingston, Willson, & Willson, 2010; Wicherts & Dolan, 2010). Furthermore, intelligence tests require normative updates, as it was discovered that IQ scores tend to increase

over time; this is known as the Flynn effect (Flynn, 1999). A meta-analysis of 53 studies conducted in industrialized nations showed an average of a 17.6 point increase in IQ between 1951 and 2011 (Trahan et al., 2014). Another meta-analysis examined the Flynn effect by utilizing over a century's worth of data from nearly four million participants in 31 counties in attempts to identify factors contributing to the Flynn effect (Pietschnig & Voracek, 2015). Pietschnig & Voracek (2015) discovered IQ gains were more closely associated with improvements in education, improvements in nutrition, and multiplier effects or gene-environment interactions.

Research regarding the heritability of intelligence has relied on the measurement of IQ to represent intelligence (Arslan & Penke, 2015; Deary, Spinath, & Bates, 2006; Plomin & Spinath, 2004). Evidence suggests IQ is heritable; however, these estimates of heritability vary across environments (Mandelman & Gringorneko, 2011). Research shows that not all environmental factors influence individuals in the same way or to the same extent. Genetics and environmental factors have been show to interact to produce gene by environment interactions which have been documented to lead to the genetic stability and increasing heritability of intelligence across middle childhood (Trzaskowski, Yang, Visscher, & Plomin, 2014). Indeed, the heritability of intelligence has been shown to change across the lifespan, as heritability reflects both the influence of genetics independent of environment and the additional influence of gene by environment interactions, sometimes via epigenetics (Sauce & Matzel, 2018). In children around 4-5 years old the heritability of IQ is estimated to be approximately a correlation of 0.22; by 16 years old, the heritability of IQ is estimated to be approximately a correlation of 0.62; and by 50 years old, the heritability of IQ is estimated to be approximately a correlation of 0.80, with some estimates as high as 0.90 (Bouchard, 1997; Haworth et al., 2009; Sauce & Matzel, 2018). While

IQ is more difficult to measure around age 4-5, the measures of IQ at age 16 are generally considered to be equally as reliable as those measures of IQ used at age 50, which suggests the increasing heritability of IQ is more likely related to a gene by environment interaction (Sauce & Matzel, 2018). Of note, the heritability of IQ, and subsequently the role of the environment, has been shown to vary based on socioeconomic status (SES). Several twin studies have shown genes account for a greater variance in IQ among high SES families than in low SES families (Harden, Turkheimer, & Loehlin, 2007; Tucker-Drob, Rhemtulla, Harden, Turkheimer, & Fask, 2011; Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003), suggesting differences in genes are more accentuated in advantageous environments whereas differences in familial environments are more pronounced in disadvantaged environments. Factors in addition to SES, albeit related to SES, that influence IQ are educational attainment (Crawford & Allen, 1997; MacKintosh, 2011; Rindermann & Thompson, 2016), and parental level of education and occupation (Kendler et al., 2015).

Currently, a widely accepted and validated theory of intelligence is the Cattell-Horn-Carroll (CHC) three-stratum theory. CHC theory was utilized as the primary theoretical rationale behind the development of the Woodcock-Johnson Test of Cognitive Abilities, which, at the time of this writing, is on its 4th edition (WJ-IV-COG; Schrank, McGrew, & Mather, 2014). Other intelligence tests in use today include the Wechsler scales (*Wechsler Preschool and Primary Scale of Intelligence-4th Edition* (WPPSI-IV; Wechsler, 2012), *Wechsler Intelligence Test for Children-5th Edition* (WISC-V; Wechsler, 2014a), *Wechsler Adult Intelligence Scale-4th Edition* (WAIS-IV; Wechsler, 2008), the Kaufman scales (*Kaufman Assessment Battery for Children-2nd Edition* (KABC-II; Kaufman & Kaufman, 2004a), *Kaufman Brief Intelligence Test-2nd Edition* (KBIT-II; Kaufman & Kaufman, 2004b), the *Differential Ability Scales-2nd Edition* (DAS-II;

Elliot, 2007), the *Cognitive Assessment System* (CAS; Naglieri & Das, 1997), the *Stanford-Binet-5th Edition* (SB-V; Roid, 2003), and *the Reynolds Intellectual Assessment Scales- 2nd Edition* (RIAS-2; Reynolds & Kamphuas, 2015). Of these tests, the DAS-II, RIAS-2, and SB-V use CHC theory as their primary theoretical rationale. The WISC-V was updated to more closely reflect CHC theory than previous iterations of the test (Wechsler, 2014b). The Kaufman scales use a combination of CHC theory and Luria's neuropsychological theory.

Independent Living Skills

Most neuropsychological and psychological evaluations include some form of assessment of a patient's ability to independently and successfully complete age-appropriate activities of daily living or adaptive behavior. This information is often used to aid in the determination of functional deficits, in differential diagnosis, and in the development and implementation of interventions. The term 'adaptive behavior' is generally utilized primarily in the pediatric literature, and/or when in reference to intellectual disability and other neurodevelopmental disorders, whereas 'activities of daily living (ADLs)' is generally used primarily in the adult and geriatric literature in reference to dementia or neurocognitive disorders. Both terms are umbrella terms to refer to a wide range of skills needed in everyday life. Both adaptive behavior and activities of daily living are requisite skills for independent living. Therefore, research regarding the construct of adaptive behavior, activities of daily living, and independent living skills could be considered to be reflective of the same functional abilities construct. Adaptive skills include a range of competencies and a universal definition has not been established. Most definitions, however, include the concepts of personal independence and social responsibility (Luckasson et al., 2002; Reva & Bardos, 2011), as well as recognize that adaptive skills are culturally, contextually, and developmentally dependent (Reschly, 1982; Reva & Bardos, 2011). Activities

of daily living (ADLs) are traditionally dichotomized into instrumental activities of daily living (IADLs) and basic activities of daily living (BADLs; Jefferson, Paul, Ozonoff, & Cohen, 2006). IADLs include skills such as preparing food, managing medication, using a telephone, driving or using transportation, managing finances, housekeeping, doing laundry, and shopping (Jefferson et al., 2006). BADLs include skills such as self-care, feeding, toileting, bathing, grooming, dressing, and ambulating (Jefferson et al., 2006).

Doll (1935) was the first researcher to propose the use of a standardized scale for measuring social competence from infancy through adulthood, called the Vineland Social Maturity Scale. Doll (1935) conceptualized adaptive behavior as multidimensional, and organized adaptive behavior into six domains: self-help, locomotion, communication, occupation, self-direction, and socialization. This scale, currently the *Vineland-II* (Sparrow, Cicchetti, & Balla, 2005a), has been revised to organize adaptive behavior around 4 domains: communication, daily living skills, socialization, and motor skills (Sparrow, Cicchetti, & Balla, 2005b). The Vineland-II is still in use today for individuals from birth to 90 years old skills (Sparrow, Cicchetti, & Balla, 2005b).

The use of adaptive behavior in assessments became popularized when Public Law 94-112 (1975) mandated the collection of data regarding a student's adaptive behavior for special education evaluations, primarily when one suspects a cognitive disability or intellectual developmental delay (Oakland & Houchins, 1985). As of 2002, the American Association on Intellectual and Developmental Disabilities (AAIDD) has promoted a model of adaptive behavior highlighting three conceptual domains: conceptual, social, and practical skills (Wei, Oakland, & Algina, 2008). Conceptual skills include receptive and expressive language skills, reading and writing, basic arithmetic, handling money, and self-direction (Sattler & Levin,

2014). Social skills include social reasoning and comprehension, interacting with others, as well as establishing and maintaining friendships (Sattler & Levin, 2014). Practical skills include dressing, bathing, basic self-care skills, managing medication, basic housekeeping skills, and using a telephone or a computer (Sattler & Levin, 2014). This definition of adaptive skills is reflected in current diagnostic considerations for Intellectual Disability/Intellectual Developmental Disorder in the *Diagnostic and Statistical Manual of Mental Disorders- 5th Edition* (DSM-5; APA, 2013). Others have delineated adaptive behavior to include 10 critical skills: communication, community use, functional academics, school/home living, health and safety, leisure, self-care, self-direction, social skills, and vocational skills (Luckasson et al., 2002; Wei, Oakland, & Algina, 2008). The discrepancy between conceptualization of functional skills, whether dubbed adaptive behavior, ADLs, or independent living skills, has led to inconsistency within the literature as to which specific skills or sets of skills are being evaluated, thus complicating generalizability of the results and clinical implications.

Adaptive behavior has been implicated in a wide variety of neurologic and psychiatric conditions. Research has demonstrated adaptive behavior or functional deficits in activities of daily living in individuals with Autism Spectrum disorder (Adreon, & Durocher, 2007; Farley, et al., 2009; Matson, Dempsey, & Fodstad, 2009), Intellectual Disability (Ditterline, Banner, Oakland, & Becton, 2008; Matson, Dempsey, & Fodstad, 2009; Tabert et al., 2002), Down syndrome (Ditterline, et al., 2008), Specific Learning disorders (Ditterline, et al., 2008), Fragile X syndrome (Fisch, Simensen & Schroer, 2002), Williams syndrome (Mervis & Klein-Tasman, 2000), Traumatic Brain Injury (Lindén, Boschain, Eker, Schalén, & Nordström, 2005), dementia and neurocognitive disorders (Cooke, Fischer, Mayberry, & Oakley, 2000), Multiple Sclerosis (Johansson, et al., 2007), Huntington's disease (Hamilton, et al., 2003), Parkinson's disease

(Weintraub, et al., 2004), brain tumors (Huang et al., 2001), Schizophrenia (Narvaez, et al., 2008; Patterson, et al., 2001), visual and hearing impairments (Beach, Robinet, & Hakim-Larson, 1995; Crews & Campbell, 2004), depressive disorders (Adams, Sanders, & Auth, 2004; Rogers & Holm, 2000), Post-Traumatic Stress Disorder (Khalili & Mahmoudi, 2017; Jackson, et al, 2014), externalizing behavior disorders (Clark, Prior, & Kinsella, 2002), as well as other neurodevelopmental disorders (Ditterline, et al., 2008). This is not an exhaustive list of conditions with implications in adaptive behavior or activities of daily living, as any psychiatric disorder in order to constitute being a "disorder" must have implications for the daily functioning of the individual according to the DSM-5 (APA, 2013). Both adaptive behavior and activities of daily living are umbrella terms which consist of the skills and behavior needed to successfully function well in daily life, including skills necessary to live independently (Jefferson, Paul, Ozonoff, & Cohen, 2006).

The question as to which method of evaluating activities of daily living or adaptive skills best represent the person's everyday functioning is debated in the literature. Self- or informant-report questionnaire measures are subject to bias, as demonstrated by the studies below; however, these questionnaires allow for information to be gathered across multiple environments and for a wider range of activities over an extended period of time than do confrontational testing tasks (Sikkes, de Lange-de Kler, Pijnenburg, Scheltens, & Uitedhaag, 2009). Indeed, self-assessment has been shown to be subjected to many possible sources of bias (e.g. above-average effects, the planning fallacy, impression management, overconfidence, information deficits, etc.) as people have demonstrated a tendency to overestimate their skills in a variety of domains, including health, education, and the workplace (Dunning, Heath, & Suls, 2004). Furthermore, research has shown older adults, regardless of diagnostic category (e.g. mild or major

neurocognitive decline, schizophrenia, etc), tend to have poor insight into their functional deficits (DeBettignies, Mahurin, & Pirozzolo, 1990; Farias, Mungas, & Jagust, 2005; Tucker-Drob, 2011).

The assessment of adaptive behavior typically occurs most often indirectly through rating-forms or interviews (Marcotte, Scott, Lamat, & Heaton, 2010). This is particularly true for children and adolescents as they can often not only complete rating forms for themselves, but teachers and parents/guardians can provide more objective information. For example, a meta-analysis of 269 studies compared informants' (teachers, parents, and self-report) ratings on behavioral checklists (*Child Behavior Checklist* (CBCL; Achenbach, 1991a), *Teacher's Report Form* (TRF; Achenbach, 1991b), and *Youth Self-Report* (YSR; Achenbach, 1991c)) and found the following correlations: a mean *r* of .60 between similar informants (i.e. both were teachers, both were caregivers, or both were mental health professionals), a mean *r* of .28 between different informants (i.e. caregivers and teachers, caregivers and mental health professionals), a mean *r* of .22 between self-reports and ratings by others (Achenbach, 1993). These relatively low correlations among informants suggests adaptive behavior is relatively situationally specific, and to get a more accurate picture of adaptive behavior, multiple informants or confrontational tasks should be utilized.

One study by Loewenstein et al. (2001) examined the relationship between caregiver ratings on the *Caregiver's Perceptions of Functional Status Scale* (CPFS; Loewenstein & Argüelles, 1990) compared to patient's performance on the *Direct Assessment of Functional Status* (DAFS; Loewenstein et al., 1989). The CPFS was developed in conjunction with the DAFS to measure the same functional abilities; such as, orientation to time, telling time, using a telephone, mailing a letter, managing money, eating, dressing, and grooming (Loewenstein et al.,

2001). Loewenstein et al. (2001) had 72 patients with probable Alzheimer's disease complete the DAFS and *Mini-Mental Status Examination* (MMSE; Folstein, Folstein, & McHugh, 1975), while their caregivers completed the CPFS. They found caregivers significantly overestimated functional abilities of patients to tell time, manage money, and eat using utensils. The higher the patient's MMSE score, the more likely the caregiver was to overestimate the patient's functional abilities, despite still showing measured functional impairments on the DAFS (Loewenstein et al., 2001). This suggests that caregivers or informants may be susceptible to judgement errors potentially due to reporter bias, lack of opportunity to observe the skill, or incorrect attributions (i.e. attributing a patient's inability to complete as task as an unwillingness to do so or vice versa).

Similarly, Wadley, Harrell, & Marson (2003) evaluated the accuracy of caregiver and patient reports with a direct measurement of the patient's ability to manage finances. This study consisted of 20 patients diagnosed with probable Alzheimer's disease and their caregivers, as well as 23 control participants and their caregivers, who were administered the *Financial Capacity Instrument* (FCI; Marson et al., 2000), and asked to complete the *Prior Financial Capacity Form* (PFCF; Wadley, Harrell, & Marson, 2003) and the *Current Financial Capacity Form* (CFCF; Wadley, Harrell, & Marson, 2003). Results suggest patients with probable Alzheimer's disease have limited insight into their own functional deficits, and caregivers are susceptible to both overestimation and underestimation of patient's measured ability to manage their finances. Overestimation of financial abilities was most common in cash transaction skills, whereas underestimation of financial ability was more common in broad financial conceptual knowledge and the more complex checkbook management skills (Wadley, Harrell, & Marson,

2003). This study further illustrates the necessity for direct measurement of functional skills via confrontational tasks, as informants are susceptible to bias and/or information deficits.

Similar results were found when examining driving ability (Wild & Cotrell, 2003). Patients and informants completed a driving safety questionnaire with a Likert scale to rate level of impairment in 10 driving skills. The patients then completed a road test with a certified rehabilitation specialist who rated the patient on those same 10 driving skills. When comparing self- and informant-reports with an independent evaluation of driving skills in older adults with probable Alzheimer's disease, Wild & Cortrell (2003) found significant overestimation between self-reports of driving ability and observed driving ability, as well as an overestimation between informant-reports and observed driving behavior. Wild & Cortrell (2003) noted the informants endorsed a general concerns for the patient's driving; however, they underestimated the severity of the skill deficits displayed by the patients.

Another study examined the relationship between self- and caregiver reports with measured cognitive abilities in 46 Caucasian and 65 Hispanic individuals (Farias, Mungas, & Jagust, 2005). This study used the MMSE, the *Spanish and English Neuropsychological Assessment Scales* (SENAS; Mungas et al., 2000), the *Daily Function Questionnaire* (DFQ; Jorm and Jacomb, 1989) and the *Informant Questionnaire on Cognitive Decline in the Elderly* (IQCODE; Jorm and Jacomb, 1989). Similarly to previous studies, they found participants with memory impairments underestimated their level of decline in functional abilities (i.e. they lack insight into their own deficits), however, informant ratings were significantly correlated with the direct measures of cognition.

The aforementioned studies investigated an important concept: the accuracy of self or informant reports on functional abilities when compared to directly measured skills. Generally,

these studies demonstrated bias in self-reports, often overestimations of skills, and showed mixed results regarding informant-reports. However, these studies relied on report measures and direct measures that have limited validity and reliability data available (Sikkes et al., 2008). Additionally, they rely on relatively small sample sizes which limits the generalizability of the results. Moreover, the accuracy of informants' rating has been shown to be dependent on a number of variables, including the number of hours spent with the identified patient, and the informants' own cognitive and executive functioning abilities (Dassel & Schmitt, 2008; Sikkes et al., 2008) which were not explicitly included in the aforementioned studies. As such, these potential sources of bias in informants' rating further supports the use of objective, confrontational measures of functional impairment.

Unlike questionnaire methods, performance-based tasks typically require the person to complete the task in a controlled laboratory or clinical setting. Three categories or types of performance-based measures have been developed; behavioral simulation measures which require individuals to complete everyday tasks in a clinical or laboratory setting with the quality of performance compared to a normative standard, paper-and-pencil type tasks assessing everyday problem solving and cognition through real-world problems, and direct observation which requires observation of an individual completing an everyday activity in a naturalistic setting (McAlister, Schmitter-Edgecombe, & Lamb, 2016). Research on direct observation of naturalistic tasks is relatively limited as there is a large variety of methodologies utilized (e.g. vocational, kitchen, hospital, store, or home environments), generally small sample sizes, relatively few studies compare naturalistic tasks to other well-validated performance-based measures, and the efficacy of naturalistic tasks has not been demonstrated across neurological or psychiatric populations (Roberston & Schmitter-Edgecombe, 2017). Several simulation modules

have been developed to create facsimiles of natural environments (e.g. *Easy Street*, Guynes, 1985); however efficacy data is limited, with some studies showing no significant results (Richardson, Law, Wishart, & Guyatt, 2000).

Behavioral simulation measures, such as the *Independent Living Scale* (ILS; Loeb, 1996), *Rivermead Behavioral Memory Test- 3rd Edition* (Wilson et al., 2008), *Behavioral Assessment of the Dysexecutive Syndrome* (Wilson, Alderman, Burgess, Emslie, & Evans, 1996), the *Naturalistic Action Test* (NAT; Schwartz, Segal, Veramonti, Ferraro, & Buxbaum, 2002), and the *Texas Functional Living Scale* (TFLS; Cullum, Saine, & Welner, 2009) require the individual to complete confrontational tasks that mimic those tasks they would be expected to complete during every day activities. These measures combine methods used in more traditional cognitive testing with tasks that are contextually relevant to activities of daily living (Robertson & Schmitter-Edgecombe, 2017). Studies have shown behavioral simulation performance-based measures are more sensitive to functional deficits than everyday problem solving paper-and-pencil tasks (Burgess et al., 2006; Fortin, Godbout, & Braun, 2003; Marcotte & Grant, 2010). However, one limitation of these behavioral simulation tasks is the potentially limited ecological validity of the tests as the tasks are performed under contrived laboratory or clinical conditions, which may require more abstract thinking or imagination as the context clues may be more limited in a laboratory or clinical setting than in a natural everyday setting (Robertson & Schmitter-Edgecomber, 2017). This limitation in generalizability reflects the "competence/performance distinction" (p. 1140) in which what the individual is capable of doing (i.e. their competence) and what the individual actually does (i.e. their performance) are not always the same (Harvey, Velligan, & Bellack, 2007). Characteristics theorized to influence performance that are not reflective of competence are the individual's level of confidence,

motivation, willingness to take risks, ability to self-monitor and self-evaluation (Harvey, Velligan, & Bellack, 2007). Performance-based measures are more likely to reflect an individual's competence or ability to do the task, whereas an informant-report is more likely to reflect perception of an individual's performance in naturally-occurring everyday settings, which may account for some of the discrepancy within the literature in terms of variance explained by performance-based measures compared to informant questionnaires.

The Relationship between Intelligence and Independent Living Skills

Throughout the literature there has been significant variability in the relationship between cognitive tasks and everyday functioning. A meta-analysis of articles examining the ability of various cognitive tasks to predict functional status on various measures of ADLs found a large variability between studies, ranging from 0% to 80%, with an average of 21% (*SD* = 20.20; Royall et al., 2007). Royall et al. (2007) found general cognition (measures of *g*) and executive functioning accounted for more variance in functional status on measures of ADLs than did memory, attention, visuospatial, or language domains. Cognitive measures explained significantly more variance in judiciary competency determinations (53%) compared to when measures of ADLs were used as the outcome variable (averaging 20% variance explained; Royall et al., 2007). This suggests the relationship between cognitive variables and measures of ADLs is variable dependent on the measures utilized; although, cognitive variables seem to play a key role in judiciary competency decisions and functional status determinations. Moreover, longitudinal data (n = 452 at time 6) suggests changes in IADLs and neurocognitive processes over time are most likely accounted for by a single underlying cognitive variable (*g*) rather than domain specific deficits (Tucker-Drob, 2011). Other research has shown BADLs, such as dressing, grooming, and bathing, are highly correlated with motor functioning and coordination

rather than higher level cognitive processes (Bennet et al., 2002; Boyle et al., 2002) One study suggested IADL questionnaires and confrontational measures predicted observed naturalistic task completion in an on-campus apartment, whereas cognitive measures were not predictive of naturalistic performance (Schmitter-Edgecombe, Parsey, & Cook, 2011).

Moreover, another meta-analysis of 132 studies examining the relationship between cognition and activities of daily living in individuals with mild cognitive impairment found the total variance in functional status which was explained by cognition ranged from 0.01% to 88%, with a mean of 20%, across studies (McAlister et al., 2016). McAlister et al. (2016)'s results showed across studies cognition accounted for 23% of the variance in functional status ($p <$ .001), with effect sizes for the cognitive domains ranging from medium to large with executive functioning explaining significantly more of variance in functional status (37%) than attention (33%), working memory (31%), visuospatial abilities (26%), memory (23%), language (22%), and processing speed (20%). In this meta-analysis, neither age ($p = .62$) nor educational attainment ($p = .32$) moderated the relationship between cognitive data and functional status (McAlister et al., 2016). Although no study has explicitly examined ADLs in their relation to CHC theory, some broad abilities, such as *Gwm*, *Gv*, and *Gs*, are likely to be similar to the measured constructs of working memory, visuospatial abilities, and processing speed. It is important to note, this meta-analysis focused on samples of individuals with mild cognitive impairment, as such, they may have specific deficits in one or more of the aforementioned cognitive domains which may lead to a larger impact on the variance in ADLs than would be seen in a typical population with generally average skills. Furthermore, McAlister et al.'s (2016) analyses revealed statistically significant differences between the amount of variance in independent living skills which was explained by cognitive abilities varied based on the type of

measurement used to evaluate ADLs; performance-based measures, specifically the use of behavioral simulation measures accounted for 32% of the variance, and report-based measures accounted for statistically less variance, with informant-report accounting for 28% and self-report accounting for 21%. This suggests performance-based measures are more reflective of cognitive variables than reports, which may be attributable to the competence/performance distinction; the individual's ability to do the skill may be more related to cognition whereas whether or not they demonstrate the skill in everyday life performance is more likely to be reflected on report measures of ADLs.

An estimate of the correlation between reported adaptive skills and measured intelligence varies, but is generally found to be around .40 to .60 (Drozdick & Cullum, 2011; Harrison & Oakland, 2003; Murray, McKenzie, & Murray, 2013; Su et al., 2007). Estimates of the correlation between adaptive skills and intelligence are reportedly higher when teachers are the informants than when parents are the informants (Barry & Kamphaus, 2010). This is suggested to be potentially due to an emphasis teacher's place on the use of academic skills in activities of daily livings, as academics are highly related to intelligence, whereas parent's may place more of an emphasis on social skills (Barry & Kamphaus, 2010). Similarly, Murray, McKenzie, & Murray, (2013) found conceptual skills (e.g. communication, functional academics, and self-direction) on the ABAS-2 (Harrison & Oakland, 2003) were more strongly related to FSIQ on the WISC-IV ($r = 0.64$) than were social skills ($r = 0.56$)), in a sample of 102 Scottish children with diagnosed Intellectual Disability. In this study, the practical domain (e.g. self-care, health and safety, and community use) yielded similar results as the conceptual domain, with correlations to FSIQ being 0.64 (Murray, McKenzie, & Murray, 2013). These results

demonstrate the heterogeneity of the construct of adaptive behavior, suggesting various skills therein are uniquely related to intelligence.

The relationship between intelligence and adaptive behavior is also important to assess in a clinical population. In children with IQs ranging from 61-70 (n = 186), adaptive functioning, as measured by the *Vineland Adaptive Behavior Scales* (Sparrow et al., 1984) was the strongest predictor of educational attainment for children with Intellectual Disability and with Autism (de Bildt, Sytema, Kaijer, Sparrow, & Minderaa, 2005). Specifically, de Bildt et al. (2005) found autism behaviors typically associated with poor adaptive skills, even in those without an Autism diagnosis, was predictive of the child achieving a lower level of educational attainment than could be accounted for by variation in IQs. This suggests adaptive behavior is a distinct construct from intelligence within a clinical population, with certain adaptive behaviors more strongly linked to functional outcomes, such as educational attainment.

Drozdick and Cullum (2011) used the standardization sample data from the WAIS-IV, which was co-normed with the WMS-IV (Wechsler, 2009) and TFLS, to compare performance across the three tests for the overall normative sample and clinical groups. The Full-Scale Intelligence Quotient (FSIQ) and General Ability Index (GAI) from the WAIS-IV correlated most highly with performance on the TFLS (r = .41, & r = .37, respectively) in the overall normative sample, with the index scores correlating between .32 and .35 (Drozdick, & Cullum, 2011). In a sample of individuals with Alzheimer's disease, correlations between the WAIS-IV and TFLS increased for all subtest and composite scores, with the FSIQ and GAI demonstrating correlations of .68 and .62, respectively (Drozdick, & Cullum, 2011). Similarly, a clinical group of individuals with Autism showed increased correlations between FSIQ and GAI with TFLS performance (r = .68, & r = .46, respectively; Drozdick, & Cullum, 2011). Further, a clinical

group of individuals with traumatic brain injuries showed increased correlations compared to the overall normative sample for FSIQ and GAI with TFLS performance (r = .53, & r = .49, respectively; Drozdick, & Cullum, 2011). Conversely, in a sample of individuals with Major Depressive Disorder, correlations between the WAIS-IV and the TFSL decreased dramatically compared to the nonclinical sample, with the FSIQ and GAI correlating .09 and .12, respectively (Drozdick, & Cullum, 2011). Correlations between performance on the WMS-IV and the TFLS showed similar patterns of change across clinical groups, however, as the WMS-IV does not have an overall global composite, the visual working memory index showed the highest correlations with performance on TFLS (Drozdick, & Cullum, 2011). This study demonstrates an underlying relationship between measures of intelligence and performance-based measures of independent living skills across a large stratified sample of the United States population, as well as smaller clinical samples. Drozdick, & Cullum (2011) further demonstrate the importance a global intelligence and working memory measure in determining the relationship between intelligence and ADLS.

Su, Chen, Wuang, Lin & Wu (2007) examined the relationship between neuropsychological constructs and activities of daily living in 101 Chinese participants with Intellectual Disability using the *Wechsler Adult Intelligence Scale- 3rd Edition* (WAIS-III; Wechsler, 1997) and *Luria-Nebraska Neuropsychological Battery* (Golden et al., 1995) and *Wisconsin Card Sorting Test-64* (Kongs et al., 2000) and a created "everyday functions rating scale" (p. 21) measuring concepts of time, money, health and safety, tool use, home management, transportation use, leisure and recreation, and prevocational preparation. They found no significant relationship between executive function, visual perception/construction, or processing speed with their measure of everyday functioning; however, verbal comprehension

and employment status were significantly related to their measure of everyday functioning, together accounting for 35% of the variance (Su et al., 2007). In contrast, some research has emphasized visuoperceptual abilities (e.g. object recognition) in relationship to decline in ADLs (Glosser et al., 2001, 2002; Jefferson, Barakat, Giovannetti, Paul, & Glosser, 2006).

Furthermore, many studies have found relationships between executive functioning and decline in ADLs (Bell-McGinty, Podell, Frazen, Baird, & Williams, 2002; Boyle, Malloy, et al., 2003; Boyle, Paul, et al., 2003; Boyle, Paul, Moser, & Cohen, 2004; Cahen-Weiner, Boyler, & Malloy, 2002; Cahn-Weiner, Malloy, Boyle, Marran, & Salloway, 2000; Cahn-Weiner, Ready, & Malloy, 2003; Jefferson et al., 2006); although the previous study by Su et al. (2007) did not find a significant relationship between activities of daily living and executive functioning. This relationship is theorized to be due to the inclusion of many cognitive abilities within executive functioning, such as working memory, inhibition, sequencing, generation, and planning. Much of the previous literature does not examine individual abilities within executive functioning, but rather examine executive functioning as an aggregate, which may account for variation in results dependent upon the instrumentation for both executive functioning and independent living skills.

Jefferson (2006) did examine distinct ADLs and executive functions. Jefferson (2006) found a significant relationship between IADLs, specifically shopping and housekeeping, and inhibition/susceptibility to interference, but no significant relationship for word generation, working memory, planning, cognitive flexibility or sequencing as measured by the *Delis-Kaplan Executive Function System* (DKEFS; Delis, Kaplan, & Kramer, 2001). Bell-McGinty et al (2002) found relationships between independent living skills and measures of sequencing and perseveration. Whereas McAlister et al. (2016) found the largest variance in functional status was accounted for by switching (63%), primarily as measured by Trail Making Test B from the

Halstead-Reitan Neuropsychological Battery (Reitan & Wolfson, 1993), while inhibition (32%), planning (25%), reasoning (11%), and initiation (11%) accounted for statistically less variance. The amount of variance in every day functioning explained by executive function did not statistically differ between performance-based measures in general (25%), behavioral simulation measures specifically (29%), informant-reports (44%), and questionnaire measures of activities of daily living (36%; $p = .09$; McAlister et al., 2016). Executive function was found to account for 39% of the variance in IADLs and 34% of the variance in BADLs, although this was not a significant difference ($p = .43$; McAlister et al., 2016). While it appears executive functioning is related to successful completed of ADLs, the extent which executive function predicts ADLs, and which executive function subdomains contribute most to the relationship remain unknown.

Consistent with the literature on executive dysfunction and ADLs, Fortin (2003) found 10 patients with radiologically-confirmed frontal lobe lesions following a closed head injury had deficits on executive function measures, specifically those measuring strategic planning, which was predictive of difficulty in a meal preparation task. In other words, these patients were able to complete other activities of daily living requiring small sequences of actions, but struggled to plan and execute longer sequences of action in to successfully prepare a meal. Several different versions of cooking tasks have been found to be related to executive functioning in children with TBIs (Chevignard et al., 2010). These results further support the relationship between executive functioning and ADLs, and illuminates a possible neuroanatomical correlate for ADLs via the frontal lobe, which is commonly associated with executive functioning and motor sequencing and planning (Lezak, Howieson, Bigler, & Tranel, 2012).

Similar to the relationship between cognitive abilities and ADLS, the relationship between ADLs and neuroanatomical correlates is not well understood. Boyle et al. (2004) found

after accounting for the variance in IADLs due to executive functioning, subcortical neuropathology on neuroimaging failed to account for any additional variance. This suggests the contribution of the subcortical regions to IADLs via connections with the prefrontal cortex, which is commonly associated with executive functioning. Another neuroimaging study demonstrated a possible relationship between white matter hyperintensity (i.e. small lesions produced primarily by demyelination or axonal loss), hippocampal volume, and activities of daily living; however, only white matter hyperintensity accounted for additional variance once accounting for age (Farias et al., 2004). This further suggests the subcortical regions are involved in the cognitive processes necessary for successful completion of IADLS.

Cahn-Weiner et al. (2007) conducted a longitudinal study (n = 106) to examine changes in neuroimaging for volume of lacunes (i.e. small subcortical infarcts), white matter hyperintensity, cortical gray matter, and hippocampal volume in relation to changes in IADLs in older adults, as well as measures of memory and executive function. When accounting for age and education, both memory and executive function measures were associated with IADLs at baseline, but only executive function measures predicted change in IADLs (Cahn-Weiner et al., 2007), which is consistent with previous literature demonstrating the relationship between IADLs and executive functioning. In terms of neuroimaging, Cahn-Weiner et al. (2007) did not find a relationship between white matter hyperintensity and IADLs at baseline ($p = .1$) or change in IADLs ($p = .4$), unlike Farias et al.'s (2004) previous study. Cahn-Weiner et al. (2007) did, however, find cortical gray matter ($p < .001$) and hippocampal volume ($p < .001$) were significantly associated with IADLs at baseline, with cortical gray matter modestly predicting changes in IADL over time ($p = .05$). Cortical gray matter volume is nonspecific to certain abilities or ability deficits as cortical gray matter is typically associated with a large range of

cognitive abilities (Lezak, Howieson, Bigler, & Tranel, 2012). Conceptually, this would be consistent with IADLs as a unified construct, as IADLs require more complex processes and include a variety of abilities and skills.

Yoon et al (2013) examined the relationship between white matter hyperintensities and ADLs in 1,514 patients with amnestic mild cognitive impairment (aMCI); finding white matter hyperintensities were more associated with IADLs (e.g. using the telephone, shopping, using transportation, preparing meals, performing household chores, and participating in leisure activities) than BADLs across all three severity levels of aMCI. However, it is important to note, not all IADLs measured were significantly related to white matter hyperintensities. For example, taking medication, using household appliances, managing finances, managing belongings, keeping appointments, and talking about recent events were not significantly related to white matter hyperintensities (Yoon et al., 2013). This discrepancy between IADLs related to white matter hyperintensities is potentially related to the possibility that white matter hyperintensities are disrupting the cortico-basal ganglia-cortical and frontosubcortical loops, thus interfering with successful motor planning and execution, as it was the IADLs with a more substantial motoric component which were found to be related to white matter hyperintensities (Yoon et al., 2013).

Griffith et al. (2010) examined the relationship between the medial prefrontal cortex, hippocampal volume, the medial parietal/precunei, and the angular gyri with financial capacity in 66 participants (38 of which were diagnosed with aMCI). Griffith et al. (2010) found angular gyri volume was predictive of ability to manage finances accounting for 19% of the variance ($p <$ .01) after accounting for overall mental status, age, education, and sex. This relationship was found to be only partially mediated by arithmetic ability and attention ($p < .05$), suggesting the

angular gyri, located in the cortical gray matter, plays a distinct role in financial skills beyond basic arithmetic abilities.

Overall, there does not yet exist a consensus on the neurocognitive or neuroanatomical underpinnings of activities of daily living. It is likely the specific neurocognitive and neuroanatomical correlates vary depending on the specific ADL being evaluated. For example, the research shows involvement of motoric pathways for IADLs which require ambulation or motor planning (Yoon et al., 2013), involvement of frontal or prefrontal regions for ADLs with a larger executive function component (Chevignard et al., 2010; Fortin, 2003), and involvement of the angular gyri and arithmetic abilities for ADLs involving financial skills (Griffith et al., 2010). Global cortical involvement appears to be implicated in the greatest variety of ADLs, comparatively, this neuroanatomical region encapsulates an incredibly wide variety of cognitive abilities.

Conclusion

Despite the long history of use for both measures of intelligence and independent living skills, the relationship between these two constructs remains unclear. This may be due, at least in part, to the heterogeneity of the construct of activities of daily living or independent living skills, and the inconsistency in measures used in the literature to evaluate cognitive abilities. Many of the intelligence instruments used in the studies presented in this literature review vary in terms of the specific components of intelligence measured, and they generally lack a connection to CHC theory; therefore, it may be difficult to compare findings across studies as the specific constructs underlying the measure of intelligence may be variable. . Similarly, many of the instruments used in the aforementioned studies to measure ADLs vary in type (performance based, informant reports, etc.) and comprehensiveness (which ADLs were being explicitly measured).

In sum, inconclusive evidence of the cognitive correlates and neuroanatomical substrates associated with independent living skills demonstrates the need for further investigation into the relationship between these constructs. As cognitive ability measures are often used in neuropsychological and psychological evaluations in conjunction with measures of ADLs to make diagnostic decisions, to inform interventions, to infer prognosis, and to inform judiciary competency decisions, it is important to understand the nature of the relationship between intelligence and ADLs. The relationship between executive functions and ADLs has been demonstrated across multiple studies, although the exact nature of this relationship remains ambiguous. However, the relationship between independent living skills and various aspects of intelligence remains relatively unexamined in the literature. CHC theory, currently the most widely accepted theory of intelligence, presents an opportunity to investigate the relationship between independent living skills and intelligence at multiple levels, both globally and at the broad ability level, as independent living skills are theorized to relate to distinct cognitive constructs dependent on the nature of the skill being assessed.

CHAPTER III

METHODOLOGY

This chapter is comprised of four sections: (1) participants, (2) procedures, (3) instrumentation, and (4) statistical procedures and data analysis. The purpose of this chapter is to describe the participant recruitment and selection, data collection procedures, the measurement instruments, and statistical procedures used. This study utilized data collected from a larger study.

Participants

The participants were drawn from the larger study which recruited participants through a university research pool for undergraduate students. Approval for the study was granted via the university Internal Review Board. Consistent with university requirements, participants were granted 4 research credits toward their academic requirements for the larger study.

A sample of undergraduate college students provided a non-referred, at least largely somewhat independently living, sample. Previous literature shows variation in the relationship between intelligence and independent living skills across different samples based on diagnosis and severity (Chevignard et al., 2010; Fortin, 2003; Griffith et al., 2010; Yoon et al., 2013). Findings in a non-referred sample may provide the most generalizable information regarding the nature of the relationship between constructs within intelligence and various independent living skills, as opposed to clinical populations who are more likely to introduce confounds, such as comorbid conditions. Additionally, a college sample would consist of individuals with a presumed level of independence in their living environment, ergo these individuals would be more closely represented in the normative sample for the ILS than individuals who are in assisted living or dependent living environments, as the ILS was normed using a sample of

individuals who were currently living independently (Loeb, 1996). Furthermore, college and university students were included in the WJ-IV-COG normative sample, a reasonable percentage of whom attended a public 4-year college or university (37.7%) and of whom lived in the Midwest (21.7%). As such, the present sample of healthy college students would likely be represented in the normative sample of the WJ-IV-COG.

A previous simulation study found a sample size of 50 to 60 is necessary to sufficiently reduce type 1 error to around 0.05 or less (Naylor, Lin, Weiss, Raby, & Lange, 2010). Additionally, MacCalum, Widaman, Preacher, & Hong, (2001) recommended a ratio of subjects-to-variables around 4:1 or larger for multivariate analyses, such as canonical correlations. In the current study, the sample consisted of 50 participants.

Procedures

Permission to recruit students was granted by the university's Internal Review Board for the larger study. The larger study was available to students via an online sign-up system student's gain access to through their course enrollment. Data were collected by graduate students in the department of Educational Psychology, who had received extensive training on administration of standardized test batteries. Data collection was overseen by the study's primary investigator. Upon arrival to their scheduled appointment, the participant's informed consent for the study was obtained. Next, demographic information was obtained regarding the participant's chronological age, gender, ethnicity, handedness, college GPA, SAT/ACT score, height, weight, level of education, presence of psychiatric or medical diagnoses, prescription medication usage, parental level of education, and parental occupation(s). Tests were administered in a constant order for all participants. The order was: ILS Managing Money, ILS Managing Home and Transportation, ILS Health and Safety, WJ-IV-COG Oral Vocabulary, WJ-IV-COG Number

Series, WJ-IV-COG Verbal Attention, WJ-IV-COG Letter-Pattern Matching, WJ-IV-COG Phonological Processing, WJ-IV-COG Story Recall, and WJ-IV-COG Visualization. Each measure was administered according to the standardized procedure specified in the testing manuals. The total testing time was about 4 hours. Breaks were taken per participants' request. Data were collected across multiple semesters during the academic year. IRB approval was provided to conduct the present analysis.

Instrumentation

Woodcock-Johnson Test of Cognitive Abilities- 4th Edition

Description.

The *Woodcock-Johnson Test of Cognitive Abilities- 4th Edition* (WJ-IV-COG; Schrank, McGrew, Mather, & Woodcock, 2014) is theory-based measure of general intellectual ability, as well as broad and narrow cognitive abilities as defined by CHC theory (McGrew, LaForte, & Shrank, 2014). The WJ-IV-COG was revised from the *Woodcock Johnson - 3rd Edition Normative Update Test of Cognitive Abilities* (WJIII-NU-COG;Woodcock, McGrew, & Mather, 2007) as intelligence tests require regular normative updates in order to avoid artificially inflated scores due to the Flynn effect (Flynn, 1999). The WJ-IV-COG revision emphasized cognitive complexity and reflected contemporary CHC theory (McGrew, LaForte, & Schrank, 2014).

The WJ-IV-COG normative data were collected between 2009 and 2012. The norming samples were selected using a stratified sampling design to be representative of the U.S. population, according to the 2010 census, in regards to geographic region, sex, race, ethnicity, community type (e.g. metropolitan, micropolitan, or rural), parental education level, type of school/college (if applicable), educational attainment (adult sample only), employment status (adult sample only), and occupational level of adults in the labor force (adult sample only;

McGrew, LaForte, & Schrank, 2014). Data were collected from 7,416 individuals, which included 2,086 adults, 775 of whom were undergraduate or graduate college/university students (McGrew, LaForte, & Schrank, 2014). Of the college/university sample, 21.7% of the sampled individuals were in the Midwest region, and 37.7% were attending a public 4-year college or university. As the sample for the present study was approximately representative of the normative data, the WJ-IV-COG is considered an appropriate measure of intellectual ability for this population.

The WJ-IV-COG consists of 18 subtests for measuring general intellectual ability, seven CHC broad factors, and six CHC narrow abilities (McGrew, LaForte, & Schrank, 2014). The General Intellectual Ability (GIA) score is comprised of one subtest representing each of the seven CHC broad factors measured on the WJ-IV-COG: comprehension-knowledge (*Gc*), fluid reasoning (*Gf*), short-term working memory (*Gwm*), processing speed (*Gc*), auditory processing (*Ga*), long-term retrieval (*Glr*), and visual processing (*Gv*). The seven subtests are: Oral Vocabulary, Number Series, Verbal Attention, Letter-Pattern Matching, Phonological Processing, Story Recall, and Visualization. The seven subtests were selected to be core subtests as they have the highest factor loadings on GIA (McGrew, LaForte, & Schrank, 2014). Additionally, each core subtests had the highest factor loading on its respective CHC broad factors: Oral Vocabulary loads on *Gc* 0.87, Number Series loads on *Gf* 0.79, Verbal Attention loads on *Gwm* 0.77, Letter-Pattern Matching loads on *Gs* 0.74, Phonological Processing loads on *Ga* 0.62, Story Recall loads on *Glr* 0.57, and Visualization loads on *Gv* 0.74 (McGrew, LaForte, & Schrank, 2014).

In the current study, the seven core subtests were selected for analysis as they are considered to be a strong indicator for each of the CHC broad factors based on their individual factor loadings, as well as representative of general intellectual ability.

Reliability and validity.

Reliability refers to the consistency of a measure over time. Internal consistency reliability was calculated using a split-half procedure for subtests with only dichotomously scored items. Additionally, test-retest reliability coefficients were calculated. The median reliability statistic for each of the core subtests across all ages are as follows: Oral Vocabulary $r = 0.89$, Number Series $r = 0.91$, Verbal Attention $r = 0.86$, Letter-Pattern Matching $r = 0.90$, Phonological Processing $r = 0.84$, Story Recall $r = 0.93$, and Visualization $r = 0.85$. The median reliability statistic for GIA across all ages was $r = 0.97$ (McGrew, LaForte, & Schrank, 2014).

Validity refers to the extent to which the test measures what it reports to measure. Content validity for the WJ-IV-COG is provided via CHC research and theory, as well as factor analysis (McGrew, LaForte, & Schrank, 2014). For the subtests from the WJ-III-COG which were retained in the WJ-IV-COG, independent research in cross-battery assessment supports the CHC content classifications (Flanagan, Ortiz, & Alfonso, 2007, 2013). Structural, or internal, validity has been extensively researched and established in the *Woodcock Johnson – Revised Test of Cognitive Abilities* (WJ-R-COG: Woodcock & Johnson, 1989) and *Woodcock-Johnson – 3rd Edition Test of Cognitive Abilities* (WJ-III-COG; Woodcock & McGrew, & Mather, 2001), on which the WJ-IV-COG builds (Braden & Niebling, 2012; Keith & Reynolds, 2010). During data collection for the WJ-IV-COG, multiple exploratory cluster, factor, and confirmatory factor analyses were conducted for the first 1,517 participants (McGrew, LaForte, & Schrank, 2014). Similar analyses were also conducted on the next 3,815 norming participants after initial

revisions had been made (McGrew, LaForte, & Schrank, 2014). After normative data had been collected from all 7,416 participants, a three-stage procedure was used to assess internal structural validity. First, a split-sample random sample generation was completed, then an exploratory structural model was generated and evaluated, and finally, a confirmatory structural model analysis was cross-validated (McGrew, LaForte, & Schrank, 2014). These analyses further support the use of the WJ-IV-COG subtests as representative of the seven CHC broad abilities and overall intellectual functioning, and helped inform selection of the core seven subtests.

Concurrent validity was established between the WJ-IV-COG and the *Wechsler Intelligence Scale for Children- 4th Edition* (WISC-IV; Wechsler, 2003), *Wechsler Adult Intelligence Scale- 4th Edition* (WAIS-IV; Wechsler, 2008), *Wechsler Preschool and Primary Scale of Intelligence- 3rd Edition* (WPPSI-III; Wechsler, 2002), *Kaufman Assessment Battery for Children- 2nd Edition* (KABC-II; Kaufman & Kaufman, 2004a), *Stanford-Binet- 5th Edition* (SB-V; Roid, 2003), and *Differential Ability Scales- 2nd Edition* (DAS-II; Elliot, 2007; McGrew, LaForte, & Schrank, 2014). In comparison with the WISC-IV, the GIA on the WJ-IV-COG correlated with the FSIQ 0.86, with cluster/composite correlations ranging from 0.55 between *Gv* and the Perceptual Reasoning Index (PRI) and between *Gs* and the Processing Speed Index (PSI), to 0.79 between *Gc* and the Verbal Comprehension Index (VCI; McGrew, LaForte, & Schrank, 2014). In comparison with the WAIS-IV, the GIA on the WJ-IV-COG correlated with the FISQ 0.84, with cluster/composite correlations ranging from 0.44 between *Gs* and the PSI to 0.74 between *Gc* and the VCI (McGrew, LaForte, & Schrank, 2014). Compared to the KABC-II, the GIA on the WJ-IV-COG correlated with the Fluid-Crystallized Index 0.77, with cluster/index scores ranging in correlation from 0.37 between *Gv* on the WJ-IV-COG and *Gv* on the KABC-II

to 0.82 between *Gc* on the WJ-IV-COG and *Gc* on the KABC-II (McGrew, LaForte, & Schrank, 2014). The weaker correlation between measures of Gv may reflect a difference in narrow abilities measured by each battery; the WJ-IV-COG includes a measure of visualization and visual memory whereas the KABC-II includes a measure of visualization and spatial scanning (McGrew, LaForte, & Schrank, 2014). Moreover, independent research has suggested some subtests on the KABC-II cross-load and could be considered mixed measures of CHC abilities (Reynolds & Keith, 2007). In comparison with the SB-V, the GAI correlated with the FSIQ 0.80, with subtests ranging in correlation from 0.40 between *Gv* on the WJ-IV-COG and *Gv* on the SB-V to 0.69 between *Gwn* on the WJ-IV-COG and *Gwm* on the SB-V (McGrew, LaForte, & Schrank, 2014). The weak to moderate correlations across batteries which used CHC theory may be reflective of a lack of clear and consistent CHC structural evidence of the SB-V (Keith & Reynolds, 2010). Due to the extensive research of previous iterations of Woodcock-Johnson tests of cognitive abilities, as well as current reliability and validity statistics for WJ-IV-COG, there is theoretical and scientific evidence the WJ-IV-COG is a reliable and valid measure of intellectual functioning as outlined in CHC theory.

Independent Living Scales

History and description.

The ILS (Loeb, 1996) was called the *Community Competence Scale* (CCS; Loeb, 1983) during the initial creation of the scale (Loeb, 1996). Development began with a search of states' legal statues on guardianship and conservatorship, case law, and legal criticism on the subject, in addition to open-ended interviews with probate court judges, lawyers, physicians, psychiatrists, nurses, psychologists, social workers, and older adults to elicit their opinions on what skills were critical for independent living (Loeb, 1996). The results of the interviews and literature review

resulted in a scale with two broad domains; ability to care for oneself, and ability to care for one's property (Loeb, 1996). The two broad domains included 19 subcomponents, each with underlying specific abilities. Approximately 300 respondents across the aforementioned professions ranked the skills on a Likert scale the degree to which they were important for each of the 19 subcomponents. From these responses, the CCS was developed to include 19 subscales (Judgement, Emergencies, Acquire Money, Compensate Incapacities, Manage Money, Communication, Care Medical, Adequate Memory, Satisfactory Living Arrangement, Proper Diet, Mobility, Sensation, Motivation, Personal Hygiene, Maintain Household, Utilize Transportation, Verbal/Math, Social Adjustment, and Dangerousness) with 166 total items (Loeb, 1996). The initial item tryout sample consisted of 36 adults over the age of 65.

After the initial tryout data collection and analysis, the CCS was renamed the Independent Living Scales (ILS) for the standardization edition (Loeb, 1996). On the ILS, 78% of the items came from the CCS, and 19 CCS subscales were combined to improve internal consistency, and 24 new items were addition to improve reliability on the ILS (Loeb, 1996). The standardization edition of the IL included seven subscales: Communication, Acquiring and Managing Money, Emergencies, Memory, Physical Care, Household Arrangement and Transportation, and Social Adjustment. The ILS standardization data was collected in 1994 and 1995 in a sample which included 590 healthy adults over the age of 65, and a clinical sample of 248 adults over the age of 17, with various clinical diagnoses (Loeb, 1996). The nonclinical sample consisted of 400 older adults living independently, 100 adults living semi-independently, and 90 living dependently. Each living-status group was stratified based on age, sex, education level, race/ethnicity, and geographic region. Education level, race/ethnicity and geographic region were stratified in order to be representative of the 1993 U.S. census data (Loeb, 1996).

The clinical standardization sample for the ILS included adults with mental retardation (n = 70), adults with traumatic brain injuries (n = 48), adults with dementia (n = 20), and adults with chronic psychiatric conditions (n = 110; Loeb, 1996). Of the adults with chronic psychiatric conditions 47% were diagnosed with Major Depressive Disorder, 23% with Schizophrenia, and 30% with other conditions including Bipolar Disorder, Generalized Anxiety Disorder, Dysthymic Disorder, personality disorders, substance use disorders, and Schizoaffective disorder (Loeb, 1996).

When collecting standardization data for the ILS, examiners had to meet certain requirements such as having a master's degree in psychology, or a bachelor's degree in occupational, recreational, physical therapy, or social work with experience with functional ability assessments. Prior to approval for collecting data for the standardization sample, the examiners were required to submit a completed ILS protocol to the test developers for evaluation to ensure proper administration and scoring (Loeb, 1996). After standardization data were collected, 48 items were dropped from the scale. Additionally, subscales were rearranged according to a Q sort, and two factors were derived via factor analysis (Loeb, 1996). The final version of the ILS consisted of 7 subscales (Memory/Orientation, Managing Money, Managing Home and Transportation, Health and Safety, and Social Adjustment), 2 factors (Problem Solving and Performance/Information), and 68 items (Loeb, 1996). The Full Scale score uses standard scores with a mean of 100 and a standard deviation of 15, while the subscale scores and factor scores use *T* scores with a mean of 50 and a standard deviation of 10. These standard and *T* scores were based on the performance of the 400 adults in the nonclinical, living independently group. Of note, the distribution of raw scores was not a normal distribution. The ILS assesses

basic skills necessary to living independently, as such, the scores for the nonclinical Independent sample were negatively skewed (Loeb, 1996).

Managing Money, Managing Home and Transportation, and Health & Safety were the three ILS subtests selected for analysis in this study due to anticipated ceiling effects with the Memory/Orientation subtest in a non-referred college sample, and the inclusion of questions regarding psychiatric functioning on the Social Adjustment subtest. Therefore, Memory/Orientation and Social Adjustment were not be analyzed in this study. For this reason, the Full Scale, Problem Solving, and Performance/Information composites were not be calculated.

The Managing Money subtest evaluates basic money counting, ability to calculate and pay bills, knowledge of financial terms and concepts, and strategies for managing one's financial affairs (Loeb, 1996). The Managing Home and Transportation subtest is comprised of knowledge of basic household chores, ability to problem solve in order to properly care for a home, knowledge of transportation methods, ability to problem solve in order to successfully navigate using transportation, and ability to use common communication methods (Loeb, 1996). The Health and Safety subtest assesses knowledge of basic medical care, medication management, understanding the severity of medical emergencies, knowledge of what to do in a medical emergency, knowledge of basic self-care tasks, and knowledge of personal safety measures both inside and outside of the home (Loeb, 1996).

Reliability and validity.

The internal consistency reliability was calculated using all 590 adults from the nonclinical sample (Loeb, 1996). The internal consistency reliability is $\alpha = 0.88$ for the full scale; $\alpha = 0.87$ for Managing Money, $\alpha = 0.85$ for Managing Home and Transportation, and $\alpha = 0.86$

for Health and Safety (Loeb, 1996). The test-retest reliability was evaluated in 80 adults from a nonclinical sample (mean age = 77 years old, *SD* = 8 years) to whom the ILS was administered twice within an interval of 7 to 24 days (Loeb, 1996). The test-retest reliability was $r = 0.91$ for the full scale; $r = 0.92$ for Managing Money, $r = 0.83$ for Managing Home and Transportation, and $r = 0.88$ for Health and Safety (Loeb, 1996). Interrater reliability was evaluated by having two raters independently rate every protocol from the nonclinical sample. Interrater reliability was calculated using intraclass correlations as were as follows: = 0.99 for the full scale, $r = 0.99$ for Managing Money, $r = 0.98$ for Managing Home and Transportation, and $r = 0.96$ for Health and Safety (Loeb, 1996).

Content validity of the ILS was achieved via the Q sort to aid in the final composition of the subscales, and the consultation of professionals knowledgeable about competency issues in older adults at multiple points throughout the development of the scale (Loeb, 1996). Factorial validity was achieved using an exploratory principal component analysis with a Varimax rotation for the data from the nonclinical sample (Loeb, 1996). A 2- factor solution was found, and reflected in the Problem Solving and Performance/Information factors, with individual items having a factor loading of 0.30 or higher (Loeb, 1996). These two factors are comprised of items across all 5 subtests.

Concurrent validity was assessed in comparison with the *Wechsler Adult Intelligence Scale- Revised* (WAIS-R; Wechsler, 1981), the *MircoCog: Assessment of Cognitive Functioning* (MicroCog; Powell et al.., 1993), and the Activities of Daily Living Domain (ADL) from the Philadelphia Geriatric Center *Multilevel Assessment Instrument* (Lawton & Moss, 1982). The ADL domain from the Multilevel Assessment Instrument (Lawton & Moss, 1982) was chosen as a validity measure during the development of the ILS as the ADL domain had been in use for

over a decade, had reliability and validity data reported in the literature, and was considered to be representative of self-report measures for daily living skills, at the time of the ILS development (Loeb, 1996). The WAIS-R (Wechsler, 1981) and the ILS were administered to a nonclinical sample of 90 adults (mean age = 77 years old, *SD* = 8 years). The Full Scale IQ (FSIQ) on the WAIS-R and full scale on the ILS had correlations of $r = 0.73$, the Verbal IQ (VIQ) on the WAIS-R and the full scale on the ILS were correlated $r = 0.68$, and Performance IQ (PIQ) on the WAIS-R and the full scale on the ILS were correlated $r = 0.65$ (Loeb, 1996). Similarly, the Managing Money subtest on the ILS correlated with FSIQ on the WAIS-R $r = 0.76$, with VIQ $r = 0.76$, with PIQ $r = 0.65$, and with the WAIS-R subtests ranging in correlations from 0.49 (Picture Completion) to 0.68 (Comprehension; Loeb, 1996). Managing Money and the MicroCog subtests ranged in correlation from 0.32 (Reasoning/Calculation) to 0.60 (Attention/Mental Control; Loeb, 1996). Managing Home and Transportation on the ILS correlated with FSIQ on the WAIS-R $r = 0.78$, with VIQ $r = 0.75$, with PIQ $r = 0.67$, and with the WAIS-R subtests ranging in correlations from 0.54 (Digit Symbol) to 0.67 (Comprehension and Similarities; Loeb, 1996). Managing Home and Transportation and the MicroCog subtests ranged in correlation from 0.20 (Reasoning/Calculation) to 0.55 (Attention/Mental Control and Reaction Time; Loeb, 1996). Health and Safety on the ILS correlated with FSIQ on the WAIS-R $r = 0.70$, with VIQ $r = 0.67$, with PIQ $r = 0.60$, and with the WAIS-R subtests ranging in correlations from 0.48 (Picture Arrangement) to 0.61 (Compression; Loeb, 1996). Health and Safety and the MicroCog subtests ranged in correlation from 0.39 (Reasoning/Calculation) to 0.68 (Attention/Mental Control; Loeb, 1996). Correlations between the ILS and the ADL domain from the Multilevel Assessment Instrument were as follows: Managing Money and the ADL domain $r = 0.64$, Managing Home and Transportation and the ADL domain $r = 0.60$, and Health and Safety and the ADL domain *r*

= 0.65 (Loeb, 1996). More recent research has shown the ILS to correlate with another performance-based measure, the *Texas Function Living Scale* (TFLS; Cullum, Saine, & Welner, 2009), with correlations of 0.79 for Managing Money and the TFLS, correlations of 0.85 for Managing Home and Transportation and the TFLS, and correlations of 0.82 for Health and Safety and the TFLS (Weiner, Gehmann, Hynan, Saine, & Cullum, 2006).

At the time of the development of the ILS, there was no "gold standard" measure of functional competence to establish sensitivity and specificity for criterion-referenced cut-point (Loeb, 1996). The ILS utilized its own standardization sample data to create criterion-referenced cut scores to differentiate between adults who were living independently and those who were dependent. The cut scores were set where the highest number of independent adults scored above the cut score and the highest number of dependent adults scored below the cut score. More recent research suggests the use of lower cut-scores to more accurately predict judiciary competency decisions (Quickel & Demakis, 2013).

Construct validity for the ILS was established in the various clinical populations included in the standardization sample using chi-square analyses to compare the clinical groups to the nonclinical groups across levels of functioning (Loeb, 1996). Additionally, mean differences between clinical and nonclinical groups was evaluated (Loeb, 1996). Overall, the ILS was established to be a valid measure in adults with mental retardation, traumatic brain injury, dementia, depression, and chronic psychiatric disorders (Loeb, 1996). Furthermore, a confirmatory factor analysis of the ILS was conducted on a healthy college sample (n = 71), which supported the use of the Managing Money and Health & Safety subtests with this population (Johnson, 2015).

Research Questions

1. Is there a significant canonical correlation between the 7 broad CHC factors (Gc, Gf, Gwm, Gs, Ga, Glr, Gv) and tests of independent living skills (Managing Money, Managing Home and Transportation, and Health & Safety)?
    a. Hypothesis: Crystalized Intelligence, as measured by Oral Vocabulary, will most strongly relate to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Many of the ILS items rely on knowledge of concepts (e.g. financial terms, household chores, transportation and communication methods, medical care, self-care, etc.) and ability to communicate that knowledge successfully; therefore, it is likely these subtests (Managing Money, Managing Home and Transportation, and Health & Safety) will more strongly relate to crystalized intelligence than other CHC broad abilities.
    b. Hypothesis: Fluid Reasoning, as measured by Number Series, will moderately relate to the ILS subtests (Managing Money Managing Home and Transportation, and Health & Safety). A smaller portion of ILS items rely on problem solving ability in real-life scenarios (e.g. paying bills, handling emergencies in the home, and handling medical emergencies); therefore, it is likely these subtests (Managing Money, Managing Home and Transportation, and Health & Safety) will moderately relate to fluid reasoning.
    c. Hypothesis: Short-Term Working Memory, as measured by Verbal Attention, Cognitive Processing Speed, as measured by Letter-Pattern Matching, Auditory Processing, as measured by Phonological Processing, Long-Term Retrieval, as

measured by Story Recall, and Visual Processing, as measured by Visualization, will mildly relate to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Given administration guidelines on the ILS, it is likely short-term working memory, long-term retrieval, and cognitive processing speed will be only minimally related to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Additionally, because items are mostly based on verbal problem solving, it is likely visual processing will be minimally related to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety).

   d. Hypothesis: Managing Home and Transportation will contribute most to the relationship with the 7 broad CHC factors (*Gc, Gf, Gwm, Gs, Ga, Glr, Gv*). Managing Home and Transportation on the ILS correlated with Full Scale IQ (FSIQ), another global measure of intellectual functioning, on the *Wechsler Adult Intelligence Scale-Revised* (WAIS-R; Wechsler, 1981) 0.78; while Managing Money correlated with FSIQ 0.76 and Health and Safety correlated with FSIQ 0.70 (Loeb, 1996).

2. Does the GIA on the WJ-IV-COG significantly predict performance on the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety)?

   a. Hypothesis: The GIA on the WJ-IV-COG will significantly and largely equally predict performance on Managing Money, Managing Home and Transportation, and Health & Safety. In the ILS standardization sample, correlations between Managing Money, Managing Home and Transportation, and Health & Safety, and the Full-Scale IQ, a measure considered analogous to *g*, on the WAIS-R ranged

from 0.70 to 0.78 (Loeb, 1996). These similar correlations suggest it is likely GIA on the WJ-IV-COG, another measure considered analogous to *g*, will significantly predict ILS performance although will not significantly better predict one ILS subtest over another.

3. Will a non-referred college sample exceed the competency cut-off scores created by Loeb (1996)?
    a. Hypothesis: The non-referred college participants will likely exceed the competency cut-off scores for Managing Money, Managing Home and Transportation, and Health & Safety although likely not as much as the standardization sample. If the ILS is functioning similarly in a college sample as in a sample of older adults, which were used to create the competency cut-off scores, the college participants should score above the cut-off scores. Some of the items, however, may not relate as well to a younger sample more used to performing activities of daily living using the internet than when the test was created.
4. Will a non-referred college sample exceed the competency cut-off scores created by Quickel & Demakis (2013)?
    a. Hypothesis: The college participants will likely exceed the competency cut-off scores for Managing Money and Managing Home and Transportation. If the college sample exceeds the competency cut-off scores created by Loeb (1996) as discussed above, they will also exceed the less stringent competency cut-off scores created by Quickel & Demais (2013). If the ILS is functioning similarly in a college sample as in a sample of adults with Schizophrenia, which were used to

create the competency cut-off scores, the college participants should score above the cut-off scores as the participants are not a clinical inpatient sample.

Statistical Procedures and Data Analysis

Data analysis using canonical correlations was implemented to assess the strength of the relationship between two sets of variables: broad CHC factors and independent living skills. The CHC broad abilities included the 7 core subtests on the WJ-IV-COG: Oral Vocabulary, Number Series, Verbal Attention, Letter-Pattern Matching, Phonological Processing, Story Recall, and Visualization. The independent living skills included the three subtests from the ILS: Managing Money, Managing Home and Transportation, and Health & Safety. Canonical correlations were used to study the relationship between two sets of variables when each set contains at least two variables (Thompson, 1984). Canonical correlation were used to investigate to what extent one set of variables predicts another set of variables, as well as to determine the relative power of a single variable within a set of variables to predict the other set of variables (Thompson, 1984). Thus, a canonical correlation was an appropriate preliminary analysis of the relationship between CHC broad abilities and various independent living skills as these two variables represent a unified construct but directional relationships are not anticipated.

Canonical correlations investigated these relationships by creating linear combinations where individual scores are weighted in order to optimize the relationship between variables (Tabachnick & Fidell, 2007). After weights were determined, canonical variables were calculated for each participant, then the canonical correlation between the sets was calculated (Davis et al., 2009). A squared canonical correlation coefficient represents the portion of variance the two canonical variables, representative of the two variable sets, linearly share (Thompson, 1984). The number of canonical correlations is determined by the number of

variables in the smallest set. In this study, three canonical correlations were possible as the smaller set, ILS subtests, contains three subtests (Managing Money, Managing Home and Transportation, and Health & Safety).

With regard to the present study, canonical correlation allowed for the analysis of the null hypothesis that the two sets of variables, the 7 CHC broad abilities on the WJ-IV-COG and the ILS subtests, are independent of one another. By using a canonical correlation, the question of whether the two sets of variables are related was addressed, which allowed for the possibility of rejecting the null hypothesis. Furthermore, a canonical correlation analysis allowed for the canonical variables to be ordered with respect to their canonical correlations, such that the first pair was associated with the strongest relationship between variables, the second pair was associated with the second strongest relationship, etc. This aspect of the analysis allowed for questions regarding the nature of the relationship (i.e. which factors are contributing most to the relationship) between CHC broad factors and independent living skills to be addressed.

Additionally, a linear regression analysis was conducted using General Intellectual Ability (GIA) scores on the WJ-IV-COG to predict performance on the three ILS subtests (Managing Money, Managing Home and Transportation, and Health and Safety). The use of a regression analysis provided evidence for the extent to which various independent living skills can be extrapolated from a measure of *g*. Three linear regression analyses were conducted to understand the estimated predictive value of GIA on Managing Money, Managing Home and Transportation, and Health and Safety separately.

Description of the Sample

The current sample consists of 50 participants. The descriptive statistics for the sample are presented in Table 1. In the sample, 48% of the participants self-identified as male,

and 52% of participants self-identified as female. The participants were 76% White/Caucasian, 18% Black/African American, 4% Biracial/Multiracial, and 2% Hispanic/Latino.

Table 1: *Descriptive Statistics for the Sample*

Variable	*N*	(%)
Gender		
Male	24	48%
Female	26	52%
Race		
White/Caucasian	38	76%
Black/African American	9	18%
Biracial/Multiracial	2	4%
Hispanic/Latino	1	2%
Other	0	0%

N=50

CHAPTER IV

RESULTS

This chapter includes the results investigating the relationship between measures of CHC broad factors and measures of independent living skills in a non-referred college sample. The results of statistical analyses are summarized. This chapter is composed of three sections: (1) results and analyses, (2) statistical assumptions, and (3) summary.

Results and Analyses

Descriptive Statistics

Descriptive statistics for the results obtained from the seven subtests on the *Woodcock-Johnson Test of Cognitive Abilities- 4th Edition* (WJ-IV-COG; Schrank, McGrew, Mather, & Woodcock, 2014) and three subtests on the *Independent Living Scales* (ILS; Loeb, 1996) for the participants are included in Table 2. The WJ-IV-COG standard scores and ILS *T*-scores were based on separate normative samples. The WJ-IV-COG normative data identifies a mean standard score of 100 and a standard deviation of 15 for subtest and composite scores. The mean standard score for the WJ-IV-COG GIA was 102.14 with a standard deviation of 9.49, which falls within the average range, although is within a more restrictive range than a typical adult sample. Mean subtest scores for the current sample ranged from 98.08 (Phonological Processing) to 104.92 (Number Series); all of which fell within the average range. However, standard deviations for the current sample ranged from 8.78 (Oral Vocabulary) to 13.38 (Number Series), all of which are lower than the normative standard deviation of 15, suggesting the current sample obtained a more limited range of scores than the normative sample. The ILS normative data identifies a mean *T*-score of 50 and a standard deviation of 10 for subtest scores. Mean subtest scores for the current sample ranged from 42.80 (Managing Money) to 48.74 (Health & Safety), all of which fell within the average range, albeit on the lower end of the

average range. Standard deviations ranged from 7.14 (Health & Safety) to 8.41 (Managing Money), all of which are lower than the normative standard deviation of 10, suggesting the current sample obtained a more limited range of scores than the normative sample.

Table 2: Mean and Standard Deviation Statistics for the WJ-IV-COG and ILS

Variable	Mean	SD
WJ-IV-COG General Intellectual Ability	102.14	9.49
WJ-IV-COG Subtests		
Oral Vocabulary	102.30	8.78
Number Series	104.92	13.38
Verbal Attention	103.84	10.86
Letter-Pattern Matching	102.34	13.07
Phonological Processing	98.36	12.41
Story Recall	96.74	10.92
Visualization	98.08	11.69
ILS Subtests		
Managing Money	42.80	8.41
Managing Home & Transportation	48.06	7.95
Health & Safety	48.74	7.14

The relationships among WJ-IV-COG subtest standard scores, and ILS subtest *T*-scores were assessed using a Pearson's correlation, as summarized in Table 5. Following Cohen's (1988) guidelines, relationships with a small effect size have a correlation of r = .10 - .29, a medium effect size have a correlation of r = .30 - .49, and a large effect size have a correlation of r = .50 or greater. Only two correlations were statistically significant when comparing the relationship between WJ-IV-COG subtest scores and ILS subtest scores. The WJ-IV-COG Number Series subtest was found to have a statistically significant positive relationship, with a moderate effect size, with the ILS Managing Money subtest. The WJ-IV-COG Story Recall subtest was found to have a statistically significant positive relationship, with a moderate effect size, with the ILS Managing Money subtest. There were no other statistically significant relationships between the WJ-IV-COG subtests and the ILS subtests, with small effects sizes for each relationship.

Table 3: Correlations between WJ-IV-COG scores and ILS scores

Variable	Managing Money	Managing Home & Transportation	Health and Safety
Oral Vocabulary	.14	.16	.12
Number Series	.37**	.00	.05
Verbal Attention	.25	.10	.17
Letter-Pattern Matching	.17	-.07	-.06
Phonological Processing	.27	.02	.16
Story Recall	.47**	.17	.22
Visualization	.20	.11	.27

**significance at p < .05*
***significance at p < .01*

Research Question 1 and Canonical Correlation

A canonical correlation was used to assess the strength and nature of the relationship between independent living skills and broad CHC factors to answer the first research question: Is there a significant canonical correlation between the 7 broad CHC factors (*G*c, *G*f, *G*wm, *G*s, *G*a, *G*lr, *G*v) and subtests of independent living skills (Managing Money, Managing Home and Transportation, and Health & Safety)? Results for the canonical correlation analysis are summarized in Table 6. The canonical correlation between the ILS subtests and the WJ-IV-COG subtests produced no statistically significant results for any of the three variates. Although not statistically significant, the first canonical variate produced a canonical correlation value of .56, reflecting a moderate effect size, and a canonical R^2 of .32, suggesting that 32% of the variation in one set of variables was shared by the other set of variables. The results of this analysis are summarized in Figure 1. Additionally, the positive correlation between the sets of variables suggests that as performance on the ILS subtests increases, performance of the WJ-IV-COG subtests increases, and vice versa.

Canonical loadings, which are estimates of the relationships between individual variables and the variable set, of .30 or greater are considered to be significant contributors to the

overall relationship between the variable sets (Tabachnick & Fidell, 2007). For the WJ-IV-COG subtests, all subtests except for Oral Vocabulary had canonical loadings above .30, indicating they were important contributors to the overall relationship. Of the WJ-IV-COG subtests, Story Recall was found to be the most important contributor, followed by Number Series. Verbal Attention, Letter-Pattern Matching, Phonological Processing, and Visualization were significant, though less important, contributors to the overall relationship. With respect to the ILS subtests, Managing Money was found to be the most important contributor to the overall relationship. Health & Safety was measured to be a significant, though less important, contributor to the overall relationship, while Managing Home & Transportation was not a significant contributor.

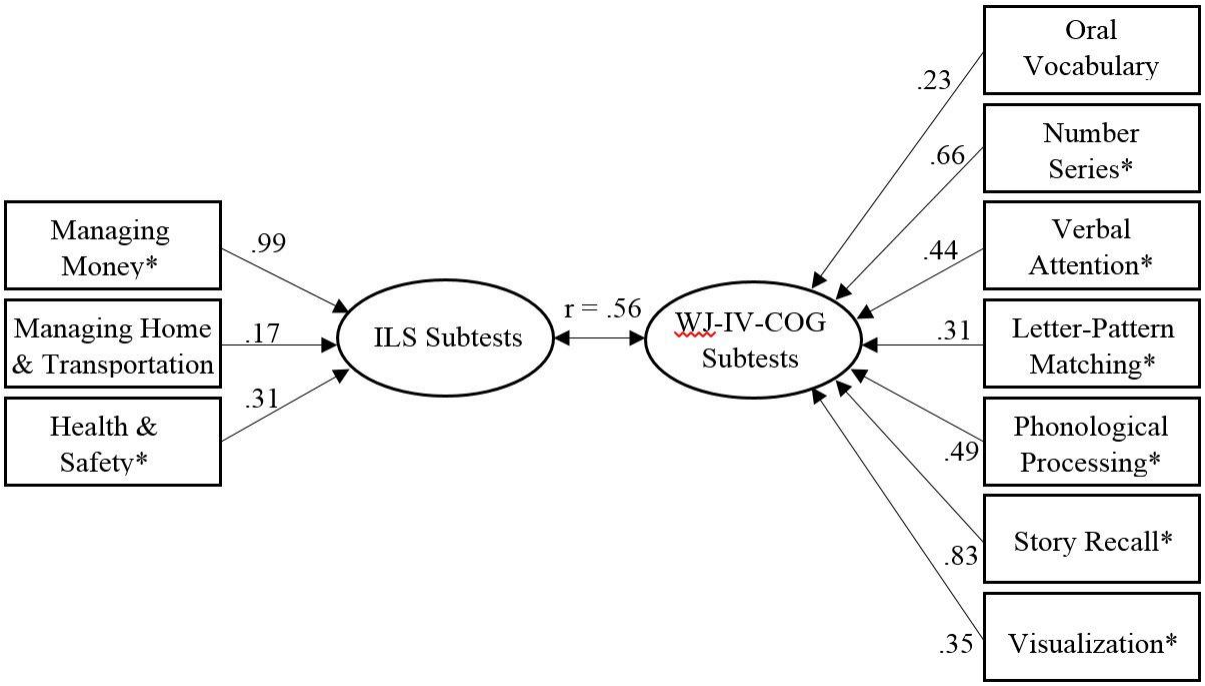
Table 4: Correlation Between Observed Variables and their Canonical Loadings

Variable	Canonical Loadings
WJ-IV-COG Subtests	
Oral Vocabulary	.23
Number Series	.66*
Verbal Attention	.44*
Letter-Pattern Matching	.31*
Phonological Processing	.49*
Story Recall	.83*
Visualization	.35*
ILS Subtests	
Managing Money	.99*
Managing Home & Transportation	.17
Health & Safety	.31*

**Significant Contributor to Overall Relationship*

FIGURE 1

Canonical Correlation Loadings for Variate Between ILS Subtests and WJ-IV-COG Subtests



**Significant Contributor to Overall Relationship, at moderate correlation level*

Research Question 2 and Linear Regression

A linear regression was used to assess the predictive nature of the relationship between independent living skills as measured by select ILS subtests and overall intelligence as measured by the WJ-IV-COG General Intellectual Ability (GIA) to answer the second research question: Does the GIA on the WJ-IV-COG significantly predict performance on the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety)? Performance on the WJ-IV-COG GIA significantly predicted performance on ILS Managing Money subtest, accounting for 21% of the variance in performance. Results for the regression analysis predicting the ILS Managing Money subtest score from the WJ-IV-COG GIA score are summarized in Table 7. Performance on Managing Home & Transportation and Health & Safety were not

significantly predicted by overall intelligence as measured by the GAI on the WJ-IV-COG. Results for the regression analysis predicting the ILS Managing Home & Transportation subtest score from the WJ-IV-COG GIA score are summarized in Table 8 and results for the regression analysis predicting ILS Health & Safety from the WJ-IV-COG GIA are summarized in Table 9.

Table 5: Multiple Regression Model Predicting ILS Managing Money from WJ-IV-COG GIA Score

Predictors	B	*SE*	β	*T*	r	R^2
Overall Model**					.46	.21
Constant	1.48	11.67		.13		
General Intellectual Ability**	.41	.11	.46	3.56		

***significance at p < .01*

Table 6: Multiple Regression Model Predicting ILS Managing Home & Transportation from WJ-IV-COG GIA Score

Predictors	B	*SE*	β	*T*	r	R^2
Overall Model					.07	.01
Constant**	41.84	12.37		3.38		
General Intellectual Ability	.06	.12	.07	.51		

***significance at p < .01*

Table 7: Multiple Regression Model Predicting ILS Health & Safety from WJ-IV-COG GAI Score

Predictors	B	*SE*	β	*T*	r	R^2
Overall Model					.17	.03
Constant**	35.91	10.98		3.27		
General Intellectual Ability	.13	.11	.17	1.17		

***significance at p < .01*

Research Question 3 and 4

Raw scores on the ILS for the current sample were compared to cut-off scores to address the third research question: Will a non-referred college sample exceed the competency cut-off scores created by Loeb (1996)? The percentage of participants scoring below these cut-off scores ranged from 24% (Health & Safety) to 48% (Managing Money). The frequency of participants

scoring below the Loeb (1996) cut-off scores are included in Table 3. Raw scores on Managing Money and Health & Safety on the ILS for the current sample were compared to cut-off scores to address the fourth research question: Will a non-referred college sample exceed the competency cut-off scores created by Quickel & Demakis (2013)? The percentage of participants scoring below these cut-off scores ranged from 2% (Health & Safety) to 4% (Managing Money). The frequency of participants scoring below the Quickel & Demakis (2013) cut-off scores are included in Table 4.

Table 8: Frequency of performance below Loeb (1996) cut-off scores on the ILS subtests

ILS Subtests	*N*	(%)
Managing Money	24	48%
Managing Home & Transportation	16	32%
Health & Safety	12	24%

N=50

Table 9: Frequency of performance below Quickel & Demakis (2013) cut-off scores on the ILS subtests

ILS Subtests	*N*	(%)
Managing Money	2	4%
Health & Safety	1	2%

N=50

Statistical Assumptions

Data were evaluated to ensure statistical assumptions of the analyses were met. To ensure minimal measurement error, data were cleaned at multiple points in the data collection process. Test measures were scored independently by two graduate students who were trained in the assessments utilized in this study. Additionally, during the data entry process, the data were cleaned to ensure accurate entry into the data set.

Normality was assessed for all variables using skewness, kurtosis, P-P plots, and scatterplot matrices. Analysis of skewness and kurtosis suggests a majority of variables approximate normal distributions, with the exception of the WJ-IV-COG Letter-Pattern

Matching subtest which was highly negatively skewed. Normality was assessed by visual analysis of P-P plots, which suggests all variables approximate normal distributions. A scatterplot matrix was utilized to assess linearity. Visual analyses of the scatterplots found no relationships to be non-linear. Homoscedasticity was assessed using a scatterplot for all variables. Visual analysis suggests the assumption of homoscedasticity has been met. Multicollinearity was assessed using correlation coefficients between variables within a set. The ILS subtests had small to moderate correlations with one another, and the WJ-IV-COG subtests had small to moderate correlations with one another. This suggests there is no multicollinearity between variables.

Summary

Overall, the mean performance of the participants was in the average range on the WJ-IV-COG subtests and ILS subtests. Performance on the ILS subtests in comparison to the cut-off scores created by Loeb (1996) and Quickel and Demakis (2013) suggests the current college sample performed worse than a sample of older adults who were tested in 1996, though the current college sample performed better than an adult clinical sample who were tested in 2013. Pearson correlation analyses indicated positive correlations between the ILS Managing Money subtest at the $p < .05$ level of significance and the following WJ-IV-COG subtests: Number Series, and Story Recall. Results of the canonical correlation analysis indicated no significant relationship between the subtests of the ILS and the subtests of the WJ-IV-COG. The first pair of variates, though not significant, had a canonical correlation value of .56 and a canonical R^2 of .32, suggests approximately 32% of the variation in one set of variables can be accounted for by the other set of variables. Managing Money from the ILS was found to be the best contributor to the overall relationship of the ILS subtests, with Health and Safety also

contributing. Story Recall from the WJ-IV-COG was the best contributor to the overall relationship of the WJ-IV-COG subtests, with all subtests except Oral Language also contributing. Overall intelligence as measured by the GAI on the WJ-IV-COG was found to significantly predict performance on the ILS Managing Money subtest at the $p < .05$ level of significance, but not performance on the ILS Managing Home & Transportation subtest or the ILS Health & Safety subtest.

CHAPTER V

DISCUSSION

This chapter contains a discussion of the current study and includes four sections: (1) summary of the current study, (2) discussion and implications of the results, (3) delimitations and limitations of the current study, and (4) directions for future research.

Summary of the Study

The purpose of the current study was to investigate the relationship between independent living skills and broad CHC factors in a sample of college students enrolled at a Midwestern university. The participants were enrolled in an undergraduate psychology course, for which they received extra credit by participating in the current study. The participants were at least 18 years of age, with a mean age of 19 years 11 months, and a standard deviation of 1 year 8 months. All participants were administered a measure of independent livings skills and a measure of seven broad CHC factors as a part of a larger study. Independent living skills were assessed using the *Independent Living Scales* (ILS; Loeb, 1996), specifically the subtests Managing Money, Managing Home & Transportation, and Health & Safety. Seven broad CHC factors were assessed using the core subtests on the *Woodcock-Johnson - 4th Edition Test of Cognitive Abilities* (WJ-IV-COG; Schrank, McGrew, & Mather, 2014), specifically Oral Vocabulary (*Gc*), Number Series (*Gf*), Verbal Attention (*Gwm*), Letter-Pattern Matching (*Gs*), Phonological Processing (*Ga*), Story Recall (*Glr*), and Visualization (*Gv*).

The relationship between independent living skills and broad CHC factors was investigated by using Pearson's correlations and canonical correlations. Mean standard scores and *T*-scores for the ILS subtests and WJ-IV-COG fell within the average range, which was largely expected given this was a non-referred college sample. The canonical correlation did not

produce a significant variate, suggesting there was not a statistically significant relationship between performance on the ILS subtests and performance on the WJ-IV-COG subtests. The first canonical variate did produce a moderate positive correlation between the ILS subtests and the WJ-IV-COG subtests. This variate indicated 32% of the variance in one set was accounted for by the other set. Managing Money on the ILS was found to be a significant contributor to the overall relationship, and to a lesser extent, Health & Safety on the ILS also contributed to the overall relationship. Of the WJ-IV-COG subtests, Story Recall was the most important contributor to the overall relationship, followed by Number Series. All of the WJ-IV-COG subtests, except for Oral Vocabulary, were found to be significant contributors to the overall relationship. Pearson's correlations indicated, of the ILS subtests, only Managing Money significantly correlated with any of the WJ-IV-COG subtests. Specifically, Managing Money moderately correlated with Story Recall and Number Series at $p < .01$. Similarly, only Managing Money on the ILS was significantly predicted by the General Intellectual Ability (GIA) on the WJ-IV-COG, at $p < .01$.

Discussion and Implications of the Relationship

Discussion

The current study investigated the relationship between broad CHC abilities and independent living skills in a non-referred college sample. The study aimed to expand upon the existing literature regarding the connection between cognitive abilities and independent living skills, as well as add to the existing literature regarding the use of a confrontation task of independent living skills, the ILS, in college students. Although independent living using confrontational measures has been well-studied (Burgess et al., 2006; Marcotte & Grant, 2010; Robertson & Schmitter-Edgecomber, 2017), the use of these types of measures for young adults still warrants investigation (Johnson, 2015). Clinicians frequently use both measures of

intelligence and measures of functional skills to address an array of referral concerns and to inform recommendations, as functional deficits are associated with a wide variety of diagnoses and conditions (Ditterline et al., 2008). Additionally, CHC theory is a well validated hierarchical model of intelligence (McGrew, 2014), and it is commonly used as a theoretical framework among school psychologists (Sotelo-Dynega & Dixon, 2014). The current literature on the relationship between cognition and independent living skills often have disparate findings, as there is little consistency in which independent living skills are being assessed and which cognitive abilities are being assessed (McAlister et al., 2016). The current study aimed to address a gap in the literature by relating independent living skills to a CHC framework.

In general, the results of the current study are largely inconsistent with the initial hypotheses. Regarding the first research question, "Is there a significant canonical correlation between the 7 broad CHC factors (*G*c, *G*f, *G*wm, *G*s, *G*a, *G*lr, *G*v) and tests of independent living skills (Managing Money, Managing Home and Transportation, and Health & Safety)," there was not an overall significant relationship found. However, despite a non-significant overall relationship, there was a moderate positive correlation between the CHC factors and independent living skills, and the common variance shared between the sets of variables was 32%. While the finding was not statistically significant, common variance of 32% between cognitive abilities and independent living skills is consistent with previous literature. McAlister et al. (2016) demonstrated that, across studies, intelligence accounted for 23% of the variance in functional status, with executive functioning explaining 37% of the variance, attention explaining 33% of the variance, and working memory explaining 31% of the variance. The increased cognitive complexity of subtests on the WJ-IV-COG (McGrew, LaForte, & Schrank, 2014) may account for the level of variance explained in the current study being more similar to

the level of variance explained by executive functioning, attention, and working memory than by other intellectual abilities.

Of the WJ-IV-COG subtests, Story Recall was found to be the most important contributor to the overall relationship. In relation to the first research question, "Is there a significant canonical correlation between the 7 broad CHC factors (*G*c, *G*f, *G*wm, *G*s, *G*a, *G*lr, *G*v) and tests of independent living skills (Managing Money, Managing Home and Transportation, and Health & Safety)," this finding is inconsistent with the hypothesis, "Crystalized Intelligence, as measured by Oral Vocabulary, will most strongly relate to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Many of the ILS items rely on knowledge of concepts (e.g. financial terms, household chores, transportation and communication methods, medical care, self-care, etc.) and ability to communicate that knowledge successfully; therefore, it is likely these subtests (Managing Money, Managing Home and Transportation, and Health & Safety) will more strongly relate to crystalized intelligence than other CHC broad abilities." One possible explanation for this finding is that within the college sample, knowledge of concepts associated with independent living skills has not yet become crystalized due to limited exposure, experience, and/or education on the various concepts. This would seem more likely than the possibility that communicating or expressing information is not an important component of the ILS. Another possible explanation for this finding is that Oral Vocabulary had the most limited range of scores compared to the other WJ-IV-COG subtests (*SD* = 8.78), which may have impacted its ability to significantly contribute to the overall relationship between broad CHC factors and independent living skills.

Story Recall is a measure of long-term retrieval (*Glr*); however, it loads 0.57 on the *Glr* composite (McGrew, LaForte, & Schrank, 2014), suggesting it is not a particularly strong

measure of long-term retrieval. According to Shrank, Decker, and Garruto (2016), the name of the subtest is "somewhat of a misnomer" (p. 160) as the subtest requires the integration of a number of cognitive abilities and processes for successful performance. For example, in addition to immediate memory, listening abilities is fundamental as the participant needs to focus on the relevant aspects of the stimuli (Oakhill, Hartt, & Samols, 2005). Additionally, as the stimuli increase in complexity, mental representations are believed to be held in working memory via the process of mapping to aid in accurate retelling (Ashcraft, 2002). Further, available background knowledge supports the construction of coherent, meaning-based mental representation of the story (Shrank, Decker, & Garruto, 2016). Executive functioning is hypothesized to contribute to successful performance on the Story Recall subtest, as well as the mental representations need to be continually updated, within working memory, to include different dimensions of meaning, such as time elements, causations, or inferences (Shrank, Decker, & Garruto, 2016). Overall, Story Recall appears to require a variety of cognitive abilities, such as, listening ability, background knowledge of the words, objects, or situations utilized within the story, attention to details, executive functioning, and working memory. The variety of cognitive abilities required on Story Recall may account, at least in part, for the finding that this subtest was the most important contributor of the WJ-IV-COG subtests to the overall relationship with independent living skills, as independent living skills are not thought to be associated with any one cognitive ability in isolation (Chevignard et al., 2010; Fortin, 2003: Griffith et al., 2010; McAlister et al., 2016; Yoon et al., 2013). Moreover, Story Recall on the WJ-IV-COG significantly correlated with Managing Money on the ILS ($p < .01$); possibly related to the variety of disparate tasks presented on the Managing Money subtest, such as factual questions, performance-based problem-solving tasks, and math computation questions.

The variety of skills needed to successfully complete both factual questions and problem solving on the Managing Money subtest may include similar cognitive abilities that are required for the Story Recall subtest, such as listening, background knowledge of words or concepts presented, attention to detail, and working memory. This argument that disparate cognitive abilities comprise the Story Recall subtest and that is why it was the most correlated with the ILS may be related to the finding that the GIA was significantly associated with Managing Money on the ILS, as Managing Money was by far the most significant contributor to the relationship of the ILS subtests. Therefore, it is possible that the variety of cognitive abilities used during Story Recall contributed to the relationship, and may possibly be consistent with the influence of GIA on the Managing Money subtest. However, this argument is somewhat mitigated by the fact that Story Recall loads 0.58 on the GIA (McGrew, LaForte, & Schrank, 2014), therefore, it is likely there is something unique to the Story Recall subtest which may be contributing to the relationship with the ILS subtests, such as the role of immediate and working memory. Administration guidelines for the ILS result in high reliance on verbal immediate and working memory in order to successful complete the task.

Number Series was found to be the second most important contributor of the WJ-IV-COG subtests to the overall relationship. In relation to the first research question, this finding is consistent with the hypothesis, "Fluid Reasoning, as measured by Number Series, will moderately relate to the ILS subtests (Managing Money Managing Home and Transportation, and Health & Safety). A smaller portion of ILS items rely on problem solving ability in real-life scenarios (e.g. paying bills, handling emergencies in the home, and handling medical emergencies); therefore, it is likely these subtests (Managing Money, Managing Home and Transportation, and Health & Safety) will moderately relate to fluid reasoning." On the WJ-IV-

COG, Number Series is a measure of fluid reasoning (*Gf*) which measures quantitative reasoning, deductive and inductive reasoning, and the executive function of placekeeping. Quantitative reasoning is needed to be able to carry out the necessary arithmetic operation utilized in the numerical pattern (Schrank, Decker, & Garruto, 2016). Deductive reasoning is needed to determine the analog or rule that governs the pattern, and inductive reasoning is needed to determine the value that complete the sequence (Schrank, Decker, & Garruto, 2016). Placekeeping is the executive function that supports the systematic exploration of serial hypotheses, which allows for hypotheses to be tested in order of plausibility without repetition (Hambrick & Altmann, 2015). Placekeeping may be utilized during the ILS, as a college student may explore various hypothesis when given real-life problem-solving scenarios before determining the correct solution or best course of action. *Gf* has been shown to play a significant role in the development of mathematical skills, including number calculation (Seethaler, Fuchs, Star, & Bryant, 2011), estimation (Namkung & Fuchs, 2016), and algebra (Singley & Bunge, 2014). Additionally, studies have shown *Gf* to be a strong predictor of mathematic skills and achievement (Cormier et al., 2017; McGrew & Wendling, 2010), as well as reading achievement (Cormier, McGrew, Bulut, & Funamoto, 2016). Specifically, Number Series on the WJ-IV-COG was found to be the strongest and most consistent predictor, of the WJ-IV-COG subtests, for basic reading skills, reading rate and fluency, and reading comprehension in school-age children (Cormier et al., 2016). Number Series on the WJ-IV-COG had moderate to strong correlation to reading achievement, whereas Number Series on the WJ-III-COG had a weak correlation to reading achievement (Evans et al., 2002; Cormier et al., 2016), which could be related to the increased cognitive complexity of the WJ-IV-COG version of the task (McGrew, LaForte, & Schrank, 2014). Number Series' relation to mathematic and reading achievement, as well as

being a measure of novel problem-solving ability, could be possible explanations as to the importance of Number Series in terms of the overall relationship between broad CHC factors and independent living skills. Some tasks on the ILS rely on problem solving ability in real-life scenarios, others rely on mathematic ability, and fewer still on reading ability. Number Series on the WJ-IV-COG significantly correlated with Managing Money on the ILS ($p < .01$); therefore, it is possible that problem solving ability may play an important role in money management skills for college students as the knowledge of financial concepts may not yet be crystallized, so there could be an increased level of novelty to the financial situations presented on the ILS.

Verbal Attention, Letter-Pattern Matching, Phonological Processing, and Visualization on the WJ-IV-COG were found to be less important, though still significant, contributors to the overall relationship. In relation to the first research question, this finding partially supports the hypothesis, "Short-Term Working Memory, as measured by Verbal Attention, Cognitive Processing Speed, as measured by Letter-Pattern Matching, Auditory Processing, as measured by Phonological Processing, Long-Term Retrieval, as measured by Story Recall, and Visual Processing, as measured by Visualization, will mildly relate to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Given administration guidelines on the ILS, it is likely short-term working memory, long-term retrieval, and cognitive processing speed will be only minimally related to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety). Additionally, because items are mostly based on verbal problem solving, it is likely visual processing will be minimally related to the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety)." Verbal Attention, Letter-Pattern Matching, and Visualization were small, though still

significant, contributors to the overall relationship with the ILS. The administration guidelines on the ILS likely minimized the effect of attention, processing speed, and visual processing.

Of the ILS subtests, a vast majority of the overall relationship with the 7 broad CHC abilities was accounted for by Managing Money. Relating to the first research question, this finding does not support the hypothesis, "Managing Home and Transportation will contribute most to the relationship with the 7 broad CHC factors (*Gc, Gf, Gwm, Gs, Ga, Glr, Gv*). Managing Home and Transportation on the ILS correlated with Full Scale IQ (FSIQ), another global measure of intellectual functioning, on the *Wechsler Adult Intelligence Scale-Revised* (WAIS-R; Wechsler, 1981) 0.78; while Managing Money correlated with FSIQ 0.76 and Health and Safety correlated with FSIQ 0.70 (Loeb, 1996)." One possible explanation for this finding is that participants performed more poorly overall on the Managing Money subtest than on the other ILS subtests, creating more variance in the scores, which may have allowed for stronger relationships to be observed.

Regarding the second research question, "Does the GIA on the WJ-IV-COG significantly predict performance on the ILS subtests (Managing Money, Managing Home and Transportation, and Health & Safety)," the results of the current study found only Managing Money on the ILS to be significantly predicted by the GIA. This finding only partially support the hypothesis, "The GIA on the WJ-IV-COG will significantly and largely equally predict performance on Managing Money, Managing Home and Transportation, and Health & Safety. In the ILS standardization sample, correlations between Managing Money, Managing Home and Transportation, and Health & Safety, and the Full-Scale IQ, a measure considered analogous to *g*, on the WAIS-R ranged from 0.70 to 0.78 (Loeb, 1996). These similar correlations suggest it is likely GIA on the WJ-IV-COG, another measure considered analogous to *g*, will significantly

predict ILS performance although will not significantly better predict one ILS subtest over another." Limited variance in scores on the GAI (*SD* = 9.49), as well as the ILS subtests Managing Home & Transportation (*SD* = 7.95) and Health & Safety (*SD* = 7.14), may account for the lack of significant findings. Participants scored worse overall on Managing Money in comparison to other ILS subtests, which may have provided the variance or range in scores necessary to find a significant relationship between the constructs.

In regards to the third research question, "Will a non-referred college sample exceed the competency cut-off scores created by Loeb (1996)," the current study found that a substantial percentage of participants scored below the Loeb (1996) cut-off scores. Regarding the third research question, the hypothesis, "The non-referred college participants will likely exceed the competency cut-off scores for Managing Money, Managing Home and Transportation, and Health & Safety although likely not as much as the standardization sample. If the ILS is functioning similarly in a college sample as in a sample of older adults, which were used to create the competency cut-off scores, the college participants should score above the cut-off scores. Some of the items, however, may not relate as well to a younger sample more used to performing activities of daily living using the internet than when the test was created." The cut-off scores were created in relation to clinical recommendations for individuals' ability to live independently, as individuals who score below the cut-off scores were determined to require assistance with activities of daily living, such as in assisted living facilities or through the use of in-home caregivers. Of the current participants, 48% scored below the cut-off score for Managing Money, 32% scored below the cut-off score for Managing Home & Transportation, and 24% scored below the cut-off score for Health & Safety. The high percentage of college students scoring below cut-off scores suggests that the ILS may not be functioning similarly in a

current college sample as in a sample of older adults who were tested in 1996, which was the sample used to create the competency cut-off scores. It is possible that college students may not have had the opportunity to achieve competency in independent living skills, or it may be possible that the test items are not reflective of methods younger people use to perform activities of daily living, such as the internet and/or smart phones. Johnson (2015) performed a confirmatory factor analysis of performance on the ILS in a sample of 71 non-referred college students. The confirmatory factor analysis supported the use of the ILS in college students as the items from the Managing Money and Health & Safety subtests mapped onto the Problem Solving and Performance/Information factors outlined by Loeb (1996), suggesting that the ILS is functioning similarly in a sample of college students as in the normative sample of older adults. In comparison to the present study, performance on the ILS in Johnson's (2015) sample was higher than the current sample, with a mean score of 48.41 for Managing Money and a mean score of 53.21 for Health & Safety. One possible explanation for the difference in performance on the ILS is the inclusion of older college students in the Johnson (2015) study, as the age range was noted to be 18 years old to 38 years old. It is possible that the older participants performed better on the ILS subtests than the younger participants, likely due to experience living independently or generational effects.

It is possible that financial management skills could develop later than health and safety skills, with home and transportation management skills developing somewhere in the middle. This may be due to a combination of factors such as education, exposure, and cultural expectations for young adults' level of independence. The FINRA Investor Education Foundation's National Financial Capability Study found that millennials exhibit more problematic financial behavior and display lower levels of financial literacy compared to Gen

Xers and Baby Boomers (Mottola, 2014). The generational discrepancy in financial literacy provides a possible explanation for the large percentage of college students in the current study scoring below the cut-off scores, as college students may be more likely to lack financial knowledge than older individuals. College students may not have had adequate experience or education to develop sufficient financial management skills, as only 16.4% of high school students nationwide are required to take a personal finance course to graduate from high school (NGPF, 2017). Conversely, 40 states in the United States require students to take at least one health or wellness course for high school graduation (Macdonald, Zinth, Pompelia, 2019). Additionally, it is recommended that students in Pre-K to 2nd grade receive a minimum of 40 hours of health education each year, and students in 3rd grade to 12th grade receive a minimum of 80 hours of health education each year (Joint Committee on National Health Standards, 2007). Therefore, college students are likely to have had more exposure to health education than financial education prior to beginning college, which may account for some of the discrepancy in performances on the ILS subtests. In regards to the fourth research question, "Will a non-referred college sample exceed the competency cut-off scores created by Quickel & Demakis (2013)," the current study found that a majority of participants scored above the Quickel and Demakis (2013) cut-off scores, which supports the hypothesis, "The non-referred college participants will likely exceed the competency cut-off scores for Managing Money and Managing Home and Transportation. If the college sample exceeds the competency cut-off scores created by Loeb (1996) as discussed above, they will also exceed the less stringent competency cut-off scores created by Quickel & Demais (2013). If the ILS is functioning similarly in a college sample as in a sample of adults with Schizophrenia, which were used to create the competency cut-off scores, the healthy college participants should score above the cut-off scores as the participants are not a

clinical inpatient sample." In the current study, 4% of participants scored below the cut-off score for Managing Money and 2% of participants scored below the cut-off score for Health & Safety. This finding suggests that, in general, the current college sample performed better than a clinical inpatient sample. Of note, the cut-off scores were created based on the performance of the clinical inpatient sample, who were tested in 2013, based on the predictive power of the cut-point in relation to legal determinations of incompetence to live independently. Test administration in 2013 would likely minimize the impact of outdated test questions when comparing the current sample to the inpatient sample, as many technological advancements which could impact independent living skills, such as ease of internet access, smart phones, and mobile or online banking, were available in 2013.

Implications for clinical practice

The findings of the current study add to the understanding of the relationship between independent living skills and broad CHC factors. This study adds to the literature discussing the importance of including measures of independent living skills and cognitive abilities during clinical evaluations. As the current study yielded a non-significant relationship between the subtests on the ILS and the core subtests on the WJ-IV-COG, clinicians should conduct an evaluation of the two constructs separately when working with a similar sample as this non-referred group of college students. Several clinical referral questions to practicing psychologists may include assessment of independent living skills: neurodevelopmental disorders (i.e. Autism Spectrum Disorder, Intellectual Disability), neurocognitive disorders, psychiatric disorders (i.e. Schizophrenia), chromosomal abnormalities (i.e. Down syndrome, Fragile X syndrome), neurological disorders (i.e. Multiple Sclerosis, Huntington's disease, Parkinson's disease), and acquired neurological deficits (i.e. traumatic brain injury, brain tumors)

may all present with a component of impaired ability to complete activities of daily living (Ditterline et al., 2008; Jackson et al., 2014; Johansson et al., 2007; Matson, Dempsey, & Fodstad, 2009; Narvaez et al, 2008). Patients with referral concerns relating to difficulties with independent living tasks should have stand-alone measures of independent livings skills administered as a part of their evaluation. With younger children, parents, caregivers, and/or teachers frequently complete rating scales to accomplish this goal but as individuals age these types of instruments become less common. For college students, clinicians should be aware of whether or not the patient has had the opportunity to develop independent living skills. Deficits in independent living skills, especially as measured on the ILS, should be interpreted with some degree of caution in college students as the test may be not be well-suited for this population and subsequently, scores may reflect lack of exposure rather than a true deficit in ability to independently carry out activities of daily living.

Furthermore, when developing interventions to improve a patient's independent living skills in a similar sample, considerations should be given to their measured strengths and weaknesses, especially fluid reasoning and long-term retrieval, as these cognitive abilities may aid or hinder the development of independent living skills, particularly skills relating to managing finances. This may be important when considering transition plans for students preparing to leave high school, as well as in the recommendation for possible vocational rehabilitation services.

Delimitations and Limitations of the Study

Delimitations

The current participants' mean scores for the WJ-IV-COG GIA, WJ-IV-COG subtests, and ILS subtests fell within the average range, suggesting the current sample performed similarly to a typical adult population. By having a sample perform similarly to the typical adult

population, the results are likely to be more generalizable to the population from which the sample was selected.

The current participants' demographics approximate the demographics of the on-campus, undergraduate population of the university. For example, in 2018, 78.7% of the on-campus undergraduate students identified as White/Caucasian, 8.3% identified as Black/African American, 1.3% identified as Asian, 3.6% identified as biracial, 5.3% identified as Hispanic, 0.1% identified as Hawaiian/other Pacific Islander, and 1.1% identified as international students (Office of Institutional Effectiveness, 2018b). In the current sample, 76% of participants identified as White/Caucasian, 18% identified as Black/African American, 4% identified as Biracial/Multiracial, and 2% identified as Hispanic. The African American students are overrepresented, in comparison to the on-campus undergraduate population from which the participants were recruited, while other minorities have less representation in the current sample. In terms of gender identity, 58.6% of the on-campus undergraduate students are female (Office of Institutional Effectiveness, 2018a), and 52% of the current participants are female. Furthermore, according to the United States 2018 census data, 60.7% of the population is White, Non-Hispanic or Latino, 13.4% is Black/African American, 5.8% is Asian, 2.7% is Biracial or Multiracial, 18.1% is Hispanic or Latino, 1.3% is American Indian or Alaskan Native, 0.2% is Native Hawaiian or other Pacific Islander. In comparison to the United States population, the current sample has a larger percentage of non-Hispanic White people, a similar representation of Black or African American people, with other minorities are generally underrepresented. The United States 2018 census indicated 50.8% of the population is female, which is a similar percentage to the current sample. While the current sample does not exactly match either the United States 2018 census or the on-campus undergraduate population, the approximate

demographics ae somewhat similar to the current sample. While a closer approximation would further increase generalizability, the current sample's demographics could be considered adequate for a reasonable degree of generalizability to the young adult population.

Furthermore, the current sample includes some participants with mental health diagnoses, which allows for the sample to more accurately reflect the population and could increase generalizability of the results. Of the current participants, 4% disclosed a diagnosis of ADHD. According to the DSM-5, 2.5% of adults are diagnosed ADHD (APA, 2013). In the current sample, 20% reported a history of traumatic brain injuries (TBIs) or concussions. Approximately 4% of the population has had a documented TBI or concussion (Schiller, Lucas, Ward, & Peregoy, 2012) although that could certainly represent an underestimation as some individuals may not seek medical care. While the results were not stratified for categories of mental health diagnoses, as the number of participants per category would have been too small, the inclusion of these participants may aid in the current sample more accurately reflecting a young adult population.

Limitations

The sample size may have limited the variability in measured performance; for instance, standard deviations for the sample were smaller relative to the normative standard deviations. This may have impacted the ability for the current analyses to yield statistically significant results. Additionally, generalizability may be limited by certain demographics of the current sample, such as the sample consisted of students who were enrolled in college, in the Midwestern United States, and who spoke English.

Another potential limitation of the current study was the lack of a measure to evaluate the degree of independence the current participants had with respect to their living situation. For

instance, it is possible that a college student may not be living independently, may not be managing his or her own finances, may not be responsible for managing their own home or living space, and may not be responsible for various aspects of their healthcare, such as health insurance. It is difficult to determine if the current participants had the opportunity to acquire independent living skills as college could be considered a transition period during which the student gains more independence. Similarly, cultural differences in the expectations for level of independence across the lifespan, particularly during the college years, could impact the generalizability of the results.

Potential limitations with the use of the ILS in a college sample include concerns related to the advancement of technology, which may make some tasks on the ILS irrelevant for college aged students. For example, 65% of Americans use online banking and 53% of smartphone owners with bank accounts utilize mobile banking (Board of Governors of the Federal Reserve System, 2016). The frequency with which online and mobile banking are used could reduce the familiarity of young adults with more traditional banking methods, thus reducing their scores on the ILS Managing Money subtest. This potential reduction in score may not be reflective of lack of competence in financial management skills, but reflective of formatting changes due to advancement in technology.

Furthermore, a National Health Interview Survey showed that 50.8% of American homes did not have a landline phone (Blumberg & Luke, 2017). This survey also indicated 60.7% of all children lived in a household without a landline phone (Blumberg & Luke, 2017). As such, participants in the present study may not have had the opportunity to learn how to use landline telephones, opting instead for wireless phones, which may have reduced some participants' scores on the ILS Managing Home & Transportation subtest. Limited exposure to landline

phones may not be reflective of a lack of competence in communication but rather reflective of evolving technologies.

Directions for Future Research

This study illuminated a need for additional research on measuring independent living skills in college students, and expectations for the level of competency in terms of independent living skills. The current study demonstrated that the college sample performed more poorly on the ILS subtests than would have been expected; however, several hypotheses have been presented, such as college students may have limited experience completing certain independent living skills, limited education on certain concepts relating to independent living skills, varying levels of expectations for college students to live independently, and advancements in technology which may have made certain ILS test items irrelevant to the assessment of independent living skills at present. Further research would be necessary to evaluate these hypotheses and determine the extent to which each hypothesis impacts performance on the ILS in college students. Additionally, this study demonstrates the need for a college-aged normative sample on the ILS to reflect advancements in technology, and to reflect the possible age-based differences in performance through the use of age-based norms.

Furthermore, additional research evaluating the relationship between broad CHC factors and independent living skills using different measures of independent living skill is needed to increase generalizability by expanding upon or supplementing the findings of the current study. The use of additional measures of independent living skills may reduce the limitations related to the potentially outdated items on the ILS for a college aged sample.

Moreover, additional research with various populations is needed to increase generalizability of the results. The present study focused on college students; however, additional

research on young adults not enrolled in college could expand upon the present study and add to the literature regarding the relationship between independent living skills and CHC factors for young adults. Additionally, research across the lifespan would provide a more comprehensive understanding of the relationship between independent living skills and CHC factors.

The current study included a percentage of participants with a previous ADHD diagnosis, as well as participants with a history of traumatic brain injury; however, additional research in clinical populations may illuminate different relationships between the broad CHC factors and independent living skills. It is possible that when a person has a severe deficit in one or more cognitive abilities, those areas of deficit may play a more significant role as potential limiting factors in their ability to complete independent living tasks.

Conclusions

The results of the current study suggest there is not a statistically significant relationship between performance on a measure of independent living skills and performance on a measure of broad CHC factors. While not a significant relationship, analyses using a canonical correlation indicated a moderate positive relationship between the two sets of variables, with a moderate percentage of the variance in one set of subtests being accounted for by the other set. Of the included ILS subtests, Managing Money was the main contributor to the relationship, while Health & Safety contributed to a lesser extent, and Managing Home & Transportation did not contribute to the relationship. One possible explanation for Managing Money being the primary contributor of the ILS subtests is that, in general, participants performed more poorly on Managing Money than the other ILS subtests, which may have provided more variability in scores allowing for a more substantial relationship to be found. Of the WJ-IV-COG subtests, all subtests, expect Oral Vocabulary, were found to be significant contributors, with Story Recall and Number Series being the largest contributors. Story Recall is a measure of long-term

retrieval, though a variety of cognitive abilities are believed to be necessary for the completion of the Story Recall tasks, including attention, immediate and working memory, and adequate background knowledge of the words and concepts presented in each story. These various cognitive abilities may be more similar to the abilities needed for successful completion of the ILS subtests as there are a variety of types of questions on the ILS, including factual questions, real-life scenarios questions, and problem-solving questions. Number Series is a measure of fluid reasoning, which requires the use of quantitative reasoning, deductive and inductive reasoning, as well as executive functioning. Fluid reasoning may aid in the completion of the tasks on the ILS, as the ILS includes problem-solving questions and math computation questions. It is also possible that fluid reasoning plays a significant role in independent living skills for college students as they may have limited previous exposure to some independent living tasks, which may increase the amount of novelty and subsequently, increase the level of problem-solving needed to complete the task.

Additionally, regression analyses indicated that overall intelligence, as measure by the GIA on the WJ-IV-COG only significantly predicted performance on Managing Money, and not on the other ILS subtests. Similar to the canonical correlation analyses, it is possible that the increased range in scores on the Managing Money subtest in comparison to the other ILS subtests allowed for significant relationships to be found.

Furthermore, frequency of raw scores were analyzed to determine the percentage of the current sample that fell below either the Loeb (1996) and Quickel and Demakis (2013) cut-off scores. A high percentage of participants scored below the cut-off scores created by Loeb (1996). This suggests that college students were not performing at the level expected in comparison to older adults who were living independently when the standardization data was

collected. Possible explanations for this finding include; limited opportunity for college students to acquire independent living skills, limited education on the concepts associated with independent living skills, deficits in financial literacy for millennials compared to older generations, discrepancies in the expectations for the level of independence college students are able to demonstrate, and advancements in technology which have made some items of the ILS irrelevant for the completion of independent living tasks in the present day.

Implications of the current study suggest, that when working with similar samples, clinicians should administer separate measures of independent living skills and cognitive abilities as the relationship between the two constructs was not significant. Overall, clinicians should be aware when measuring independent living skills that young adults, particularly college students, may lack adequate exposure or experience completing tasks of independent living, which may reduce their scores on tests of independent living without reflecting an associated deficit in an area of cognitive ability. Likewise, caution should be used when interpreting performance by a college student on the ILS, as college students may not perform at a similar level to the normative sample, possibly due to advancements in technology and/or age-related variation in expectations for the level of independence with some daily tasks. Being aware of and understanding potential differences in college students' performance with regard to independent living skills is important for accurate diagnosis and development of appropriate interventions and recommendations.

References

Achenbach, T. M. (1991a). *Manual for the Child Behavior Checklist/4-18 and 1991 Profile*. Burlington, VT: University of Vermont Department of Psychiatry.

Achenbach, T. M. (1991b). *Manual for the Teacher's Report Form and 1991 Profile*. Burlington, VT: University of Vermont Department of Psychiatry.

Achenbach, T. M. (1991c). *Manual for the Youth Self-Report and 1991 Profile*. Burlington, VT: University of Vermont Department of Psychiatry.

Achenbach, T. M. (1993). Implications of multiaxial empirically based assessment for behavior therapy with children. *Behavior Therapy, 24*(1), 91-116.

Adams, K. B., Sanders, S., & Auth, E. A. (2004). Loneliness and depression in independent living retirement communities: risk and resilience factors. *Aging & Mental Health, 8*(6), 475-485.

Adreon, D., & Durocher, J. S. (2007). Evaluating the college transition needs of individuals with high-functioning Autism Spectrum disorders. *Intervention in School and Clinic, 42*(5), 271-279.

American Bar Association, & American Psychological Association. (2008). *Assessment of Older Adults with Diminished Capacity: A Handbook for Psychologists.* Washington, D. C.: American Bar Associations Commission on Law and Aging.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. Washington, D.C: American Psychiatric Association.

Arslan, R. C., & Penke, L. (2015). Zeroing in on the Genetics of Intelligence. *Journal of Intelligence, 3*(2), 41-45.

Ashcraft, M. H. (2002). *Cognition* (3rd ed.). Upper Saddle River, NJ: Prentice.

Barry, C. T., & Kamphaus, R. W. (2010). Adaptive behavior scales. In P. J. Frick, C. T. Barry, & R. W., Kamphaus (Eds.), *Clinical assessment of child and adolescent personality and behavior* (3rd ed., pp.315-338). New York: Springer.

Bartholomew, D. J. (2004). *Measuring intelligence: Facts and fallacies*. New York, NY: Cambridge University Press.

Beach, J. D., Robinet, J. M., & Hakim-Larson, J. (1995). Self-esteem and independent living skills of adults with visual impairments. *Journal of Visual Impairment & Blindness, 89*(9), 531-540.

Bell-McGinty, S., Podell, K., Franzen, M., Baird, A. D.,&Williams, M. J. (2002). Standard measures of executive function in predicting instrumental activities of daily living in older adults. *International Journal of Geriatric Psychiatry*, *17*(9), 828–834.

Bennett, H. P., Corbett, A. J., Gaden, S., Grayson, D. A., Kril, J. J., & Broe, G. A. (2002). Subcortical vascular disease and functional decline: A 6-year predictor study. *Journal of the American Geriatric Society, 50*, 1969–1977.

Bertling, J.P. (2012). *Measuring Reasoning Ability: Applications of Rule-Based Item Generation* (unpublished doctoral dissertation). Westfälischen Wilhelms-Universität zu Münster.

Binet, A. (1903). *L'Etude experimentale de l'intelligence* [Experimental Study of Intelligence]. Paris: Schleichter.

Binet, A., & Simon, T. (1916). *The development of intelligence in children (The Binet-Simon Scale*) (E. S. Kite, Trans.). Baltimore, MD, US: Williams & Wilkins Co.

Blumberg, S. J. & Luke, J. V. (2017). Wireless substitution: Release of estimates from the National Health Interview Survey, July–December 2016. *National Center for Health*

Statistics. Retrieved from https://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201705.pdf

Board of Governors of the Federal Reserve System. (2016). *Consumers and mobile financial services.* Retrieved from https://www.federalreserve.gov/econresdata/consumers-and-mobile-financial-services-report-201603.pdf

Bornstein, M., Giusti, Z., Leach, D., & Venuti, P. (2005). Maternal reports of adaptive behaviors in Italy and United States. *Infant and Child Development, 14*, 403-424.

Bouchard, T. J. (1997). IQ similarity in twins reared apart: Findings and responses to critics. In R. J. Sternberg & E. L. Grigorenko (Eds.), *Intelligence: Heredity and Environment* (pp. 126-160). New York: Cambridge University Press.

Boyle, P. A., Cohen, R. A., Paul, R., Moser, D., & Gordon, N. (2002). Cognitive and motor impairments predict functional declines in patients with vascular dementia. *International Journal of Geriatric Psychiatry, 17*, 164–169.

Boyle, P. A., Malloy, P. F., Salloway, S., Cahn-Weiner, D. A., Cohen, R., & Cummings, J. L. (2003). Executive dysfunction and apathy predict functional impairment in Alzheimer disease. *The American Journal of Geriatric Psychiatry, 11*(2), 214–221.

Boyle, P. A., Paul, R. H., Moser, D. J., & Cohen, R. A. (2004). Executive impairments predict functional declines in vascular dementia. *The Clinical Neuropsychologist, 18*, 75–82.

Boyle, P. A., Paul, R., Moser, D., Zawacki, T., Gordon, N., & Cohen, R. (2003). Cognitive and neurologic predictors of functional impairment in vascular dementia. *The American Journal of Geriatric Psychiatry, 11*(1), 103–106.

Braden, J., & Niebling, B. (2012). Using the joint test standards to evaluate the validity evidence for intelligence tests. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary*

intellectual assessment: Theories, tests, and issues (3rd ed., pp. 739–757). New York, NY: Guilford Press.

Burgess, P. W., Alderman, N., Forbes, C., Costello, A., Coates, L. M.-A., Dawson, D. R. Channon, S. (2006). The case for the development and use of 'ecologically valid' measures of executive function in experimental and clinical neuropsychology. *Journal of the International Neuropsychological Society, 12*, 194–209.

Cahn-Weiner, D. A., Boyle, P. A., & Malloy, P. F. (2002). Tests of executive function predict instrumental activities of daily living in community-dwelling older individuals. *Applied Neuropsychology*, *9*(3), 187–191.

Cahn-Weiner, D. A., Farias, S. T., Julian, L., Harvey, D., Kramer, J. H., Reed, B. R., . . . Chui, H. (2007). Cognitive and neuroimaging predictors of instrumental activities of daily living. *Journal of the International Neuropsychological Society*, *13*, 747–757

Cahn-Weiner, D. A., Malloy, P. F., Boyle, P. A., Marran, M., & Salloway, S. (2000). Prediction of functional status from neuropsychological tests in community-dwelling elderly individuals. *The Clinical Neuropsychologist*, *14*(2), 187–195.

Cahn-Weiner, D. A., Ready, R. E., &Malloy, P. F. (2003). Neuropsychological predictors of everyday memory and everyday functioning in patients with mild Alzheimer's disease. *Journal of Geriatric Psychiatry & Neurology*, *16*(2), 84–89.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies.* Cambridge, England: Cambridge University Press.

Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment. *Journal of educational psychology, 54*(1), 1.

Cattell, R. B. (1971). *Abilities: Their structure, growth, and action*. New York: Houghton Mifflin

Centers for Disease Control and Prevention. (2015). *United States: Epidemiology and Rehabilitation.* National Center for Injury Prevention and Control; Division of Unintentional Injury Prevention. Atlanta, GA.

Chevignard, M. P., Catroppa, C., Galvin, J., & Anderson, V. (2010). Development and evaluation of an ecological task to assess executive functioning post childhood TBI: The children's cooking task. *Brain Impairment, 11*(2), 125-143.

Clark, C., Prior, M., & Kinsella, G. (2002). The relationship between executive function abilities, adaptive behaviour, and academic achievement in children with externalizing behaviour problems. *Journal of Child Psychology and Psychiatry, 43*(6), 785–796.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. 2nd edition.

Cooke, K. Z., Fischer, A. G., Mayberry W.,, & Oakley, F. (2000). Differences in activities of daily living process skills of persons with and without Alzheimer's disease. *The Occupational Therapy Journal of Research, 20*(2), 87-105.

Cormier, D. C., Bulut, O., McGrew, K. S., & Singh, D. (2017). Exploring the relations between Cattell–Horn–Carroll (CHC) cognitive abilities and mathematics achievement. *Applied Cognitive Psychology, 31*(5), 530-538.

Cormier, D. C., McGrew, K. S., Bulut, O., & Funamoto, A. (2016). Revisiting the relations between the WJ-IV Measures of Cattell-Horn-Carroll (CHC) cognitive abilities and reading achievement during the school-age years. *Journal of Psychoeducational Assessment, 35*(8), 731-754.

Crawford, J. R., & Allan, K. M. (1997). Estimating premorbid WAIS-R IQ with demographic variables: Regression equations derived from a UK sample. *The Clinical Neuropsychologist*, *11*(2), 192-197.

Crews, J. E., & Campbell, V. A. (2004). Vision impairment and hearing loss among community-dwelling older Americans: implications for health and functioning. *American Journal of Public Health, 94*(5), 823-829.

Cullum, M., Saine, K., & Welner, M. F. (2009). *Texas Functional Living Scale manual*. Minneapolis, MN: Pearson.

Dassel, K. B., & Schmitt, F. A. (2008). The impact of caregiver executive skills on reports of patient functioning. *The Gerontologist, 48,* 781–792.

Davis, A. S., Pass, L. A., Finch, W. H., Dean, R. S., Woodcock, R. W. (2009). The canonical relationship between sensory-motor functioning and cognitive processing in children with Attention-Deficit/Hyperactivity disorder. *Archives of Clinical Neuropsychology, 24,* 273-286.

Davis, A. S., Pierson, E. E., & Finch, W. H. (2011). A canonical correlation analysis of intelligence and executive functioning. *Applied Neuropsychology, 18,* 61-68.

de Bildt A., Sytema S., Kraijer D., Sparrow S. & Minderaa R. (2005) Adaptive functioning and behaviour problems in relation to level of education in children and adolescents with intellectual disability. *Journal of Intellectual Disability Research, 49*(9), 672-681.

Deary, I. J. (2001). *Intelligence: A very short introduction*. New York, NY: Oxford University Press.

Deary, I. J., Spinath, F. M., & Bates, T. C. (2006). Genetics of intelligence. *Eurpoean Journal of Human Genetics, 14,* 690-700.

DeBettignies, B. H., Mahurin, R. K., & Pirozzolo, F. J. (1990). Insight for impairment in independent living skills in Alzheimer's disease and Multi-Infarct Dementia. *Journal of Clinical and Experimental Neuropsychology, 12*, 355-363.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis Kaplan Executive Function System: Examiner's manual*. San Antonio, TX: The Psychological Corporation.

Ditterline, J., Banner, D., Oakland, T., & Becton, D. (2008). Adaptive behavior profiles of students with disabilities. *Journal of Applied School Psychology, 24*(2), 191-208.

Doll, E. A. (1935). A genetic scale of social maturity. *American Journal of Orthopsychiatry, 5*(2), 180-190.

Drozdick, L. W., & Cullum, C. M. (2011). Expanding the ecological validity of WAIS-IV and WMS-IV with the Texas Functional Living Scale. *Assessment, 18*(2), 141-155.

Dunning, D., Heath, C., & Suls, J. (2004). Flawed self-assessment: Implications for health, education, and the workplace. *Psychological Science in the Public Interest, 5*, 69–106.

Elliot, C. D. (2007). *Differential Ability Scales-Second Edition*. San Antonio, TX: Pearson Clinical.

Evans, J. J., Floyd, R. G., McGrew, K. S., & Leforgee, M. H. (2002). The relations between measures of Cattell-Horn-Carroll (CHC) cognitive abilities and reading achievement during childhood and adolescence. *School Psychology Review, 31*(2), 246-262.

Eysenck, H. J. (2012). *The measurement of intelligence*. London: Springer.

Family and Social Service Administration. (2018). *Vocational Rehabilitation services process*. Retrieved from https://www.in.gov/fssa/ddrs/5255.htm.

Farias, S. T., Mungas, D., & Jagust, W. (2005). Degree of discrepancy between self and other-reported everyday functioning by cognitive status: Dementia, mild cognitive impairment, and healthy elders. *International Journal of Geriatric Psychiatry, 20,* 827–834.

Farias, S. T., Mungas, D., Reed, B., Haan, M. N., & Jagust, W. J. (2004). Everyday functioning in relation to cognitive functioning and neuroimaging in community-dwelling Hispanic and non-Hispanic older adults. *Journal of the International Neuropsychological Society, 10,* 342–354.

Farley, M. A., McMahon, W. M., Fombonne, E., Jenson, W. R., Miller, J., Gardner, M., …, Coon, H. (2009). Twenty-year outcome for individuals with Autism and average or near-average cognitive abilities. *Autism Research, 2,* 109-118.

Fisch, G. S., Simensen, R. J., & Schroer, R. J. (2002). Longitudinal changes in cognitive and adaptive behavior scores in children and adolescents with the fragile X mutation or autism. *Journal of Autism and Developmental Disorders, 32*(2), 107–114.

Flanagan, D. P., Ortiz, S. O., & Alfonso, V. C. (2007). *Essentials of cross-battery assessment* (2nd ed.). Hoboken, NJ: Wiley.

Flanagan, D. P., Ortiz, S. O., & Alfonso, V. C. (2013). *Essentials of Cross-Battery Assessment* (3rd ed.). Hoboken, NJ: Wiley.

Fletcher, R. B., & Hattie, J. (2011). *Intelligence and intelligence testing*. New York: Taylor & Francis.

Floyd, R. G., McGrew, K. S., & Evans, J. J. (2008). The relative contributions of the Cattell-Horn-Carroll cognitive abilities in explaining writing achievement during childhood and adolescence. *Psychology in the Schools, 45*(2), 132-144.

Flynn, J. R. (1999). Searching for justice: The discovery of IQ gains over time. *American Psychologist, 54*, 5-20.

Folstein, M., Folstein, S., & McHugh, P. (1975). Mini-mental state. A practical method for grading the cognitive state of patients for the physician. *Journal Psychosomatic Research, 12,* 189–198.

Fortin, S., Godbout, L., & Braun, C. M. J. (2003). Cognitive structure of executive deficits in frontally lesioned head trauma patients performing activities of daily living. *Cortex, 39*, 273–291.

French, J. L., & Hale, R. L. (1990). A history of the development of psychological and educational testing. In C. R. Reynolds & R. W. Kamphaus (Eds.), Handbook of Psychological and Educational Assessment of Children (pp. 3-28). New York: Guilford Press.

Galton, F. (1869). *Hereditary Genius: An inquiry into its laws and consequences*. London: MacMillan and co.

Garnder, H., Kornhaber, M. L., & Wake, W. K. (1996). *Intelligence: Multiple Perspectives.* New York, NY: Harcourt Brace College Publishers.

Glosser, G., Baker, K. M., deVries, J. J., Alavi, A., Grossman, M., & Clark, C. M. (2001). Disturbed visual processing contributes to impaired reading in Alzheimer's disease. *Neuropsychologia*, *40*, 902–909.

Glosser, G., Gallo, J., Duda, N., de Vries, J. J., Clark, C. M., & Grossman, M. (2002). Visual perceptual functions predict instrumental activities of daily living in patients with dementia. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *15*(3), 198–206.

Golden, C. J., Hammeke, T. A., & Purisch, A. D. (1995). *The Luria-Nebraska Neuropsychological Battery*. Los Angeles: Western Psychological Services.

Goodwin, C. J. (2015). *A History of Modern Psychology*. 5th Ed. Hoboken, NJ: Wiley.

Griffith, H. R., Stewart, C. C., Stoeckel, L. E., Okonkwo, O. C., den Hollander, J. A., Martin, R. C., . . . Marson, D. C. (2010). Magnetic resonance imaging volume of the angular gyri predicts financial skill deficits in people with amnestic mild cognitive impairment. *The American Journal of Geriatric Society, 58,* 265–274.

Guynes, D. (1985). *Easy Street Environments*. Pheonix, AZ: Pheonix Memorial Hospital.

Hambrick, D. Z., & Altmann, E. M. (2015). The role of placekeeping ability in fluid intelligence. *Psychonomic Bulletin & Review, 22,* 1104-1110.

Hamilton, J. M., Salmon, D. P., Corey-Bloom, J., Gamst, A., Paulsen, J. S., Jerkins, S., ... & Peavy, G. (2003). Behavioural abnormalities contribute to functional decline in Huntington's disease. Journal of Neurology, *Neurosurgery & Psychiatry, 74*(1), 120-122.

Harden, K. P., Turkheimer, E., & Loehlin, J. C. (2007). Genotype by environment interaction in adolescents' cognitive aptitude. *Behavior Genetics, 37,* 273–283.

Harrison, P. L., & Oakland, T. (2003). *Adaptive Behavior Assessment System Manual* (2nd ed.). San Antonio, TX: Harcourt Assessment.

Harvey, P. D., Velligan, D. I., & Bellack, A. S. (2007). Performance-based measures of functional skills: Usefulness in clinical treatment studies. *Schizophrenia Bulletin, 33*(5), 1138-1148.

Haworth, C. M., Wright, M. J., Luciano, M., Martin, N. G., de Geus, E. J. C., van Beijsterveldt, C. E. M., . . . Plomin, R. (2009). The heritability of general cognitive ability increases linearly from childhood to young adulthood. *Molecular Psychiatry, 15*, 1112–1120.

Henager, R., & Cude, B. J. (2016). Financial Literacy and Long-and Short-Term Financial Behavior in Different Age Groups. *Journal of Financial Counseling and Planning*, *27*(1), 3-19.

Horn, J. L. (1965). *Fluid and crystallized intelligence: A factor analytic and developmental study of the structure among primary mental abilities*. Unpublished doctoral dissertation, University of Illinois, Champaign.

Huang, M. E., Wartella, J., Kreutzer, J., Broaddus, W., & Lyckholm, L. (2001). Functional outcomes and quality of life in patients with brain tumors: A review of the literature. *Brain Injury*, *15*, 843–856.

Jackson, J. C., Pandharipande, P. P., Girard, T. D., Brummel, N. E., Thompson, J. L., Hughes, C. G., ... & Hopkins, R. O. (2014). Depression, post-traumatic stress disorder, and functional disability in survivors of critical illness in the BRAIN-ICU study: a longitudinal cohort study. *The Lancet Respiratory Medicine*, 2(5), 369-379.

Jefferson, A. L., Barakat, L. P., Giovannetti, T., Paul, R. H., & Glosser, G. (2006). Object perception predicts IADL impairment in Alzheimer's disease. *Journal of Clinical & Experimental Neuropsychology*, 28(6), 884-897.

Jefferson, A. L., Paul, R. H., Ozonoff, A., & Cohen, R. A. (2006). Evaluating elements of executive functioning as predictors of instrumental activities of daily living (IADLS). *Archives of Clinical Neuropsychology*, *21*, 311-320.

Jencks, C., & Phillips, M. (Eds.). (2011). *The Black-White test score gap*. Brookings Institution Press.

Jensen, A. R. (1987). 4. The g Beyond Factor Analysis. In R. R. Ronning, J. A., Glover, J. C. Conoley, J. C. Witt (eds.). *The Influence of Cognitive Psychology on Testing*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Jensen, A. R. (1998). *The g factor: The science of mental ability*. Westport, CT: Praeger.

Jensen, A. R., & Weng, L. J. (1994). What is a good g? *Intelligence, 18*(3), 231-258.

Johansson, S., Ytterberg, C., Claesson, I. M., Lindberg, J., Hillert, J., Andersson, M., ... & von Koch, L. (2007). High concurrent presence of disability in multiple sclerosis. *Journal of neurology, 254*(6), 767-773.

Johnson, A. N. (2015). *Examining the factor structure of two subscales of the independent living scales (ILS) in a clinical sample and a college sample* (Doctoral dissertation, The University of North Carolina at Charlotte).

Johnson, W., Bouchard, T. J., Krueger, R. F., McGue, M., & Gottesman, I. (2004). Just one g: Consistent results from three test batteries. *Intelligence, 32*, 95-108.

Joint Committee on National Health Standards. (2007). National health education standards: Achieving excellence. *American Cancer Society*.

Jorm A. F., & Jacomb, P. A. (1989). The informant questionnaire on cognitive decline in the elderly (IQCODE): sociodemographic correlates, reliability, validity and some norms. *Psychologic Medicine*, 19, 1015–1022.

Kamphaus, R. W., Winsor, A. P., Rowe, E. W., & Kim, S. (2012) A history of intelligence test interpretation. In D. P. Flanagan & P. L. Harrison (Eds.), Contemporary Intellectual Assessment, Third Edition: Theories, Tests, and Issues (pp. 56-70). New York: Guilford Press.

Kaufman, A. S., Kaufman, N. L. (2004a*). Kaufman Assessment Battery for Children-Second Edition.* San Antonio, TX: Pearson Clinical.

Kaufman, A. S., Kaufman, N. L. (2004b*). Kaufman Brief Intelligence Test-Second Edition.* San Antonio, TX: Pearson Clinical.

Keith, T. Z., & Reynolds, M. R. (2010). Cattell-Horn-Carroll abilities and cognitive tests: What we've learned from 20 years of research. *Psychology in the Schools, 47*(7), 635–650.

Kendler, K. S., Turkheimer, E., Ohlsson, H., Sundquist, J., & Sundquist, K. (2015). Family environment and the malleability of cognitive ability: A Swedish national home-reared and adopted-away co-sibling control study. *Proceedings of the National Academy of Sciences of the United States of America, 112,* 4612–4617.

Khalili, R., & Mahmoudi, H. (2017). Self-care status of veterans with combat-related post traumatic stress disorder: A review article. *Journal of Nursing and Midwifery Sciences, 4*(1), 48-57.

Kongs, S. K., Thompson, L. L., Iverson, G. L. & Heaton, R., K. (2000). *Wisconsin Card Sorting Test – 64 Card Version (WCST-64) Professional Manual*. Odessa, FL: Psychological Assessment Resources.

Lezak, M. D., Howieson, D. B., Bigler, E. D., & Tranel, D. (2012). *Neuropsychological Assessment* (5th ed.). New York, NY: Oxford University Press.

Lindén, A., Boschain, K., Eker, C., Schalén, W., & Nordström, C. H. (2005). Assessment of motor and process skills reflects brain-injured patients' ability to resume independent livings better than neuropsychological tests. *Acta Neurologica Scandinavica, 111,* 48-53.

Loeb, P. A. (1996). *Independent Living Scales manual*. Minneapolis, MN: Pearson.

Loewenstein, D. A., & Argüelles, S. (1990). The Caregivers Perception of Functional Status Scale: Contrasting caregiver report and direct assessment of objective functional status. *Unpublished manuscript*.

Loewenstein, D. A., Amigo, E., Duara, R., Guterman, A., Hurwitz, D., Berkowitz, N., Wilkie, F., Weinberg, G., Black, B., Gittlelman, B., & Eisdorfer, C. (1989). A new scale for the assessment of functional status in Alzheimer's Disease and related disorders. *Journal of Gerontology*, 4, 114–121.

Loewenstein, D. A., Argüelles, S., Bravo, M., Freeman, R. Q., Argüelles, T., Acevedo, A., & Eisdorfer, C. (2001). Caregivers' judgments of the functional abilities of the Alzheimer 's disease patient: A comparison of proxy reports and objective measures. *Journal of Gerontology, 56*(2), 78-84.

Luckasson, R., Borthwick-Duffy, S., Buntinx, W., Coulter, D. L., Craig, E. M., Reeve, A., et al. (2002). *Mental retardation: Definition, classification, and systems of support* (10th ed.). Washington, D.C.: American Association on Mental Retardation.

MacCallum, R. C., Widaman, K. F., Preacher, K. J., & Hong, S. (2001). Sample size in factor analysis: The role of model error. *Multivariate Behavioral Research, 36*, 611–637.

Macdonald, H., Zinth, J. D., Pompelia, S. (2019). 50-State comparison: High school graduation requirements. *Education Commission of The States*.

Mackintosh, N. (2011). *IQ and Human Intelligence*. Oxford, UK: Oxford University Press.

Mandelman, S. D., & Grigorenko, E. L. (2011). Intelligence: Genes, environments, and their interactions. In R. J. Sternberg & S. B. Kaufman (Eds.), *The Cambridge handbook of intelligence* (85-106). New York, NY: Cambridge Univeristy Press.

Marcotte, T. D., & Grant, I. (2010). *Neuropsychology of everyday functioning*. New York, NY: The Guilford Press.

Marcotte, T. D., Scott, J. C., Kamat, R., & Heaton, R. K. (2010). Neuropsychology and the prediction of everyday functioning. In T. D. Marcotte & I. Grant (Eds.), *Neuropsychology of Everyday Functioning.* New York: Guilford Press.

Marson, D., Sawrie, S., Snyder, S., et al. (2000). Assessing financial capacity in patients with Alzheimer's disease. A conceptual model and prototype instrument. *Archives of Neurology*, 57, 877–884.

Mather, N., & Wendling, B. J. (2014). Examiner's Manual. *Woodcock-Johnson IV Tests of Cognitive Abilities*. Rolling Meadows, IL: Riverside.

Matson, J. L., Dempsey, T., & Fodstad, J. C. (2009). The effect of Autism Spectrum Disorders on adaptive independent living skills in adults with severe intellectual disability. *Research in Developmental Disabilities, 30,* 1203-1211.

McAlister, C., Schmitter-Edgecombe, M., & Lamb, R. (2016). Examination of variables that may affect the relationship between cognition and functional status in individuals with mild cognitive impairment: A meta-analysis. *Archives of Clinical Neuropsychology, 31,* 123-147.

McGrew, K. S. (1997). Analysis of the major intelligence batteries according to a proposed comprehensive Gf-Gc framework. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, tests, and issues* (pp. 151–179). New York, NY: Guilford.

McGrew, K. S. (2014). *CHC theory 101: from general intelligence g to CHC theory* [PowerPoint Slides]. Retrieved from http://www.slideshare.net/iapsych/chc-theory-101-from-general-intelligence-g-to-chc-theory.

McGrew, K. S., & Schneider, W. J. (2018, February). *Revisions to the Cattell-Horn-Carroll (CHC) theory of intelligence*. Presented at the National Association of School Psychology Conference, Chicago, IL.

McGrew, K. S., LaForte, E. M., & Schrank, F. A. (2014). Technical Manual. *Woodcock-Johnson IV Tests of Cognitive Abilities*. Rolling Meadows, IL: Riverside.

Mervis, C. B., & Klein-Tasman, B. P. (2000). Williams syndrome: Cognition, personality, and adaptive behavior. *Mental Retardation and Developmental Disabilities Research Reviews, 6*(2), 148–158.

Mottola, G. R. (2014). The financial capability of young adults—A generational view. *Insights: Financial capability—march*.

Mungas, D., Reed, B. R., Marshall, S. C., González, H. M. (2000) Development of psychometrically matched English and Spanish neuropsychological tests for older persons. *Neuropsychology, 14*, 209–223.

Murray, A. J., McKenzie, K., & Murray, G. (2013). To what extent does g impact on conceptual practical and social adaptive functioning in clinically referred children? *Journal of Intellectual Disability Research, 58*(8), 777-785.

Naglieri,, J. A., & Das, J. P. (1997). Das-Naglieri Cognitive Assessment System. Chicago, IL: Riverside.

Namkung, J. M., & Fuchs, L. S. (2016). Cognitive predictors of calculations and number line estimation with whole numbers and fractions among at risk students. *Journal of Educational Psychology, 108*(2), 214.

Narvaez, J. M., Twamley, E. W., McKibbin, C. L., Heaton, R. K., & Patterson, T. L. (2008). Subjective and objective quality of life in Schizophrenia. *Schizophrenia Research, 98*, 201-208.

Naylor, M. G., Lin, X., Weiss, S. T., Raby, B. A., & Lange, C. (2010). Using canonical correlation analysis to discover genetic regulatory variants. *PloS one, 5*(5), e10395.

NGPF. (2017) Who has access to financial education in American high schools today. Next Gen Personal Finance. Retrieved from http://www.ngpf.org

Oakhill, J., Hartt, J., & Samols, D. (2005). Levels of comprehension monitoring and working memory in good and poor comprehenders. *Reading and Writing*, 18(7-6), 657-686.

Oakland, T., & Houchins, S. (1985). A review of the Vineland Adaptive Behavior Scales, Survey Form. *Journal of Counseling and Development, 63*, 585-586.

Office of Institutional Effectiveness. (2018a). *Headcount by Gender.* Retrieved from https://www.bsu.edu/about/factbook/enrollment

Office of Institutional Effectiveness. (2018b). *Headcount by Race*. Retrieved from https://www.bsu.edu/about/factbook/enrollment

Patterson, T. L., Goldman, S., McKibbin, C. L., Hughs, T., & Jeste, D. V. (2001). UCSD performance-based skills assessment: Development of a new measure of everyday functioning for severely mentally ill adults. *Schizophrenia Bulletin, 27*(2), 235-245.

Pietschnig, J., & Voracek, M. (2015). One century of global IQ gains: A formal meta-analysis of the Flynn Effect (1909 –2013). *Perspectives on Psychological Science, 10,* 282–306.

Plomin, R., & Spinath, F. M. (2004). Intelligence: genetics, genes, and genomics. *Jounral of personality and social psychology, 86*(1), 112.

Public Law 94-112, 94 U.S.C. § 575 (1975)

Quickel, E. J., & Demakis, G. J. (2013). Independent Living Scales in civil competency evaluations: Initial findings and prediction of competency adjudication. *Law and Human Behavior, 37*(3), 155-162.

Rabin, L. A., Paolillo, E., & Barr, W. B. (2016). Stability in test-usage practices of clinical neuropsychologists in the United States and Canada over a 10-year period: A follow-up survey of INS and NAN members. *Archives of Clinical Neuropsychology, 31*(3), 206-230.

Rehabilitation Act of 1973, 29 U.S.C. 728a (1973).

Reitan, R. M., & Wolfson, D. (1993). *The Halstead-Reitan Neuropsychological Battery*. Tucson, AZ: Neuropsychology Press.

Reschly, D. J. (1982). Assessing mild mental retardation: The influence of adaptive behavior, sociocultural status, and prospects for nonbiased assessment. In C. R. Reynolds, & T. B. Gurkin (Eds.), *The Handbook of School Psychology*, New York: John Wiley & Sons.

Reva, K. K., & Bardos, A. N. (2011). Assessing adaptive skills in a pediatric population. In A. Davis (Ed.), *Handbook of Pediatric Neuropsychology* (pp.245-249). New York, NY: Springer Publishing Company.

Reynolds, C. R., & Kamphuas, R. W. (2015). *Reynolds Intellectual Assessment Scales- 2nd Edition*. Torrance, CA: WPS Publishing.

Reynolds, M. R., & Keith, T. Z. (2007). Spearman's law of diminishing returns in hierarchical models of intelligence for children and adolescents. *Intelligence, 35*(1), 267−281.

Richardson, J., Law, M., Wishart, L., & Guyatt, G. (2000). The use of simulated environment (Easy Street) to retrain independent living skills in elderly persons: A randomized controlled trial. *Journal of Gerontology: Medical Sciences, 55,* 578–584.

Rindermann, H., & Thompson, J. (2016). The cognitive competences of immigrant and native students across the world: An analysis of gaps, possible causes and impact. *Journal of Biosocial Science, 48,* 66–93.

Robertson, K., & Schmitter-Edgecombe, M. (2017). Naturalistic tasks performed in realistic environments: A review with implications for neuropsychological assessment. *The Clinical Neuropsychologist, 31*(1), 16-42.

Rogers, J. C., & Holm, M., B. (2000). Daily-living skills and habits of older women with depression. *The Occupational Therapy Journal of Research, 20,* S68-S85.

Roid, G. H., (2003). *Stanford-Binet Intelligence Scales-Fifth Edition*. Itasca, IL: Riverside.

Royall, D. R., Lauterbach, E. C., Kaufer, D., Malloy, P., Coburn, K. L., & Black, K. J. (2007). The cognitive correlates of functional status: A review from the committee on research of the American Neuropsychiatric Association. *The Journal of Neuropsychiatry and Clinical Neurosciences, 19,* 249–265.

Sattler, J. M. (2008). *Assessment of Children: Cognitive Foundations, 5th Edition*. San Diego, CA: Jerome M. Sattler, Publisher, Inc.

Sattler, J. M., & Levin, E. (2014). Adaptive behavior. In J. M. Sattler (Ed.), *Foundations of Behavioral, Social, and Clinical Assessment of Children* (6th ed, pp. 375-394).

Sauce, B., & Matzel, L. D. (2018). The paradox of intelligence: Heritability and malleability coexist in hidden gene-environment interplay. *Psychological bulletin*, *144*(1), 26-47.

Schiller, J. S., Lucas, J. W., Ward, B. W., & Peregoy, J. A. (2012). Summary health statistics for U.S. adults: National health interview survey. *National Center for Health Statistics, 10*(252).

Schmitter-Edgecombe, M., Parsey, C., & Cook, D. J. (2011). Cognitive correlates of functional performance in older adults: Comparison of self-report, direct observation, and performance-based measures. *Journal of the International Neuropsychological Society, 17*, 853–864.

Schneider, W. J., & McGrew, K. S. (2012). The Cattel-Horn-Carroll model of intelligence. In D. Flanagan & P. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, tests, and issues* (3rd ed., pp.99-144). New York: Guilford Press.

Schrank, F. A., Decker, S. L., & Garruto, J. M. (2016). *Essentials of WJ IV cognitive abilities assessment*. John Wiley & Sons.

Schrank, F. A., McGrew, K. S., & Mather, N. (2014). *Woodcock-Johnson IV Tests of Cognitive Abilities*. Rolling Meadows, IL: Riverside Publishing.

Schrank, F. A., Miller, D. C., Wendling, B. J., & Woodcock, R. W. (2010). *Essentials of WJ III cognitive abilities assessment* (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Schwartz, M. F. Segal, M., Veramonti, T., Ferraro, M. & Buxbaum, L. J. (2002). The Naturalistic Action Test: A standardized assessment for everyday action impairment. *Neuropsychological Rehabilitation, 12*(4), 311-339.

Seethaler, P. M., Fuchs, L. S., Star, J. R., & Bryant, J. (2011). The cognitive predictors of computational skill with whole versus rational numbers: An exploratory study. *Learning and Individual Differences, 21,* 536–542.

Sikkes, S. A. M., de Lange-de Klerk, E. S. M., Pijnenburg, Y. A. L., Scheltens, P., & Uitdehaag, B. M. J. (2008). A systematic review of instrumental activities of daily living scales in dementia: Room for improvement. *Journal of Neurology, Neurosurgery & Psychiatry, 80*, 7–12.

Singley, A. T. M., & Bunge, S. A. (2014). Neurodevelopment of relational reasoning: Implications for mathematical pedagogy. *Trends in Neuroscience and Education, 3*(2), 33–37.

Sotelo-Dynega, M., & Dixon, S. G. (2014). Cognitive assessment practices: A survey of school psychologists. *Psychology in the Schools, 51*(10), 1031-1045.

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984) *Vineland Adaptive Behavior Scales* (Survey ed.). Circle Pines, MN: American Guidance Service.

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005b). *Vineland Adaptive Behavior Scales manual* (2nd Ed.). Minneapolis, MN: Pearson (AGS).

Sparrow, S. S., Cicchetti, D. V., Balla, D. A. (2005a). Vineland Adaptive Behavior Scales (2nd ed). Minneapolis, MN: Pearson.

Spearman, C. (1904). "General intelligence" objectively determined and measured. *American Journal of Psychology,* 15, 201-293.

Su C.Y., Chen C.C., Wuang Y.P., Lin Y.H., & Wu Y.Y. (2007). Neuropsychological predictors of everyday functioning in adults with intellectual disabilities. *Journal of Intellectual Disability Research, 52*(1), 18-28.

Tabachnick, B. G. & Fidell, L.S. (2007). *Using multivariate statistics*. Allyn & Bacon/Pearson Education.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics*. Boston, MA: Pearson.

Tabert, M. H., Albert, S. M., Borukhova-Milov, L., Camacho, Y., Pelton, G., Lui, X.,…, Devanand, D. P. (2002). Functional deficits in patients with mild cognitive impairment. *Neurology, 58*(5), 756-765.

Terman, L. (1916). *The measurement of intelligence: An explanation of and a complete guide for the use of the Stanford revision and extension of the Binet-Simon Intelligence Scale.* Boston, MA: Houghton Mifflin.

Thompson, B. (1985). *Canonical Correlation Analysis: Uses and Interpretation.* Beverly Hills, CA: Sage Publications.

Thurston, L. L. (1926). The mental age concept. *Psychological Review, 33*, 268-278.

Thurston, L. L. (1938). *Primary Mental Abilities*. Chicago: University of Chicago Press.

Trahan, L. H., Stuebing, K. K., Fletcher, J. M., & Hiscock, M. (2014). The Flynn effect: A meta-analysis. *Psychological Bulletin, 140,* 1332–1360.

Trzaskowski, M., Yang, J., Visscher, P. M., & Plomin, R. (2014). DNA evidence for strong genetic stability and increasing heritability of intelligence from age 7 to 12. *Molecular psychiatry*, *19*(3), 380-384.

Tucker-Drob, E. M. (2011). Neurocognitive functions and everyday functions change together in old age. *Neuropsychology, 25*, 368–377.

Tucker-Drob, E. M., Rhemtulla, M., Harden, K. P., Turkheimer, E., & Fask, D. (2011). Emergence of a Gene x socioeconomic status interaction on infant mental ability between 10 months and 2 years. *Psychological Science, 22,* 125–133.

Turkheimer, E., Haley, A., Waldron, M., D'Onofrio, B., & Gottesman, I. I. (2003). Socioeconomic status modifies heritability of IQ in young children. *Psychological Science, 14*, 623–628.

United States Census Bureau. (2018). *QuickFacts: United States*. Retrieved from https://www.census.gov/quickfacts/fact/table/US/PST045217

Wadley, V. G., Harrell, L. E., Marson, D. C. (2003). Self- and information report of financial abilities in patients with Alzheimer's Disease: Reliable and valid? *Journal of the American Geriatrics Society, 51*, 1621-1626.

Wechsler, D. (1939). *The measurement of adult intelligence*. Baltimore: Williams & Wilkins.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale-Third Edition (WAIS-III).* San Antonio: TX: Psychological Corporation.

Wechsler, D. (2002). *Wechsler Preschool and Primary Scale of Intelligence- 3rd Edition* (WPPSI-III). Bloomington, MN: Pearson Clinical.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV).* Bloomington, MN: Pearson Clinical.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale–Fourth Edition (WAIS–IV).* San Antonio, TX: Pearson.

Wechsler, D. (2009). *Wechsler Memory Scale–Fourth Edition (WMS–IV).* San Antonio, TX: Pearson.

Wechsler, D. (2012). *Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition (WPPSI-IV).* Bloomington, MN: Pearson Clinical.

Wechsler, D. (2014a). *Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V).* Bloomington, MN: Pearson Clinical.

Wechsler, D. (2014b). *WISC-V Technical and interpretive manual.* Bloomington, MN: Pearson.

Wei, Y., Oakland, T., & Algina, J. (2008). Multigroup confirmatory factor analysis for the Adaptive Behavior Assessment System-II Parent Form, Ages 5-21. *American Journal on Mental Retardation, 113*(3), 178-186.

Weintraub, D., Moberg, P. J., Duda, J. E., Katz, I. R., & Stern, M. B. (2004). Effect of psychiatric and other nonmotor symptoms on disability in Parkinson's disease. *Journal of the American Geriatrics Society, 52*(5), 784-788.

Wicherts, J. M., & Dolan, C. V. (2010). Measurement invariance in confirmatory factor analysis: An illustration using IQ test performance of minorities. *Educational Measurement: Issues and Practice, 29*(3), 39-47.

Wild, K., & Cortell, V. (2003). Identifying driving impairment in Alzheimer disease: A comparison of self and observer reports versus driving evaluation. *Alzheimer Disease and Associated Disorders, 17*(1), 27-34.

Wilson, B. A., Alderman, N., Burgess, P. W., Emslie, H. E., & Evans, J. J. (1996). *Behavioural Assessment of the Dysexecutive Syndrome*. Bury, St Edmunds: Thames Valley Test Company.

Wilson, B. A., Greenfield, E., Clare, L., Baddeley, A., Cockburn, J., Watson, P., Nannery, R. (2008). *The Rivermead behavioral memory test – Third edition* (RBMT-3). London: Person Assessment.

Woodcock, R. W., & Johnson, M. B. (1989). *Woodcock-Johnson Psycho-Educational Battery–Revised*. Rolling Meadows, IL: Riverside.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson- 3rd Edition Tests of Cognitive Abilities.* Rolling Meadows, IL: Riverside.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2007). *Woodcock-Johnson III Normative Update Tests of Cognitive Abilities*. Itasca, IL: Riverside.

Yoakum, C. S., & Yerkes, R. M. (1920). *Army Mental Tests*. New York: Henry Holt and company.

Yoon, B., Shim,Y. S., Kim,Y.-D., Lee, K. O., Na, S.-J., Hong,Y.-J., . . . Yang, D.-W. (2013).Correlation between instrumental activities of daily living and white matter hyperintensities in amnestic mild cognitive impairment: Results of a cross-sectional study. *Neurological Sciences, 34*, 715–721.